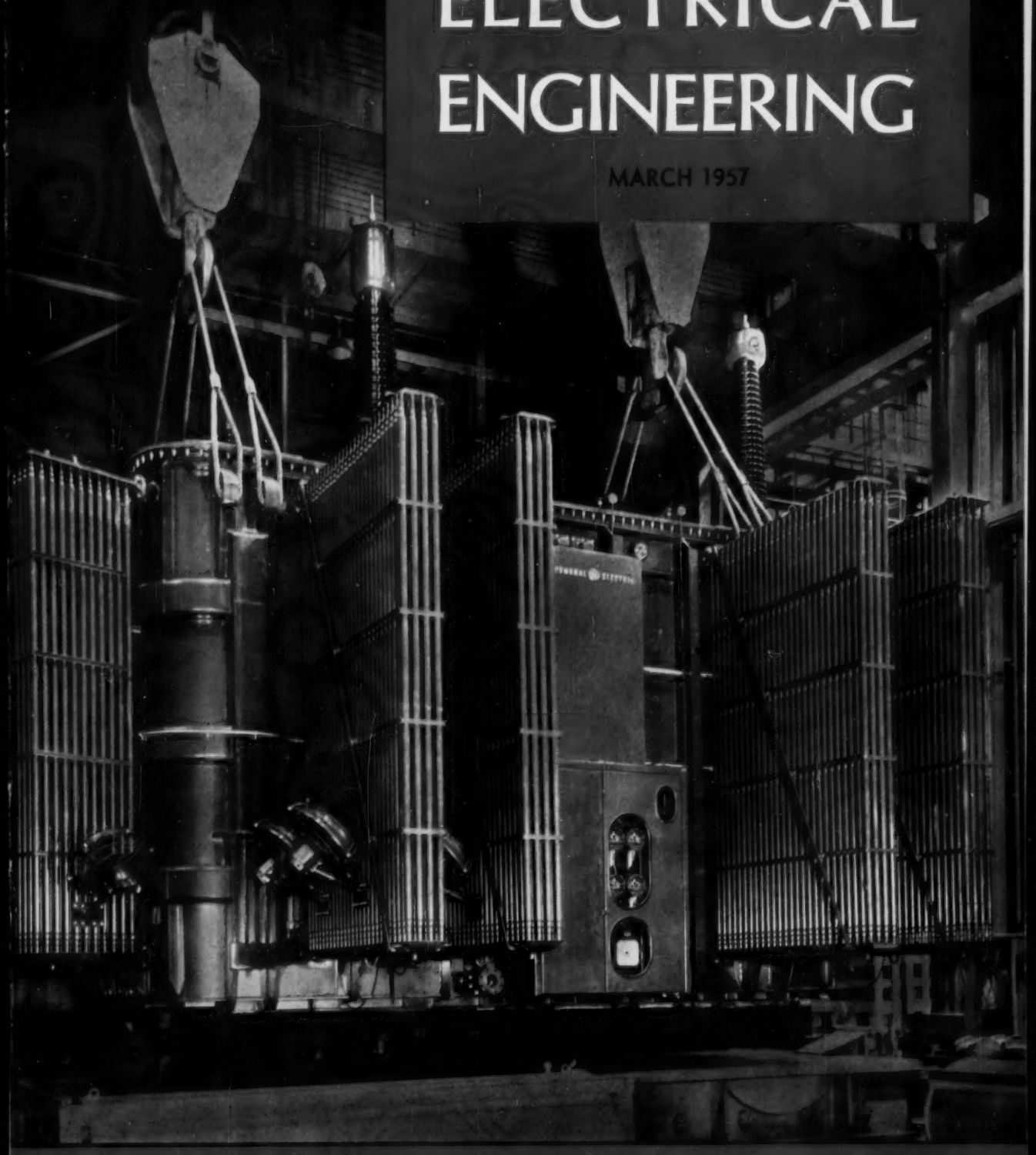
ELECTRICAL ENGINEERING

MARCH 1957



THE ARISTOCRACY OF THE ENGINEER

GERMAN RADIO OBSERVATORY STOCKERT

SUPERMENDUR, RECTANGULAR LOOP MAGNETIC MATERIAL

BELL SYSTEM SPEAKERPHONE • PIPE LINE DIGITAL TELEMETERING

ONE-TON TEST

proves physical strength of "Integrated" field coils in ALLIS-CHALMERS MOTORS

It's not likely a field coil of a motor would ever be punished this way. But tests like this illustrate the inherent ability of Allis-Chalmers "INTEGRATED" FIELD COILS to withstand the stresses created by the most severe loading conditions of a motor.

Available only on Allis-Chalmers Motors

"Integrated" field coils, available only on Allis-Chalmers motors, are enveloped in oriented glass fibers and heat-stabilized resins. These are securely locked to poles to resist mechanical force. High dimensional stability and tensile strength characteristics assure long life under the toughest of operating conditions.

Coils are surface sealed against atmospheric contaminants. In addition, the coefficient of expansion of insulation is similar to that of copper. Heat transfer qualities are excellent. "Integrated" coil structures can withstand the most severe thermal cycling found in normal operation.

Exclusive Allis-Chalmers

"Double-protection," combining new "Integrated" field coils with *Silco-Flex* all-silicone stator coil insulation, is available for rotating and stationary elements of large ac or dc machines with operating temperatures through Class B range.

For the whole story of Allis-Chalmers motors, contact your local A-C representative or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.

Silco-Flex is an Allis-Chalmers trademark.

ALLIS-CHALMERS

A-5276

ELECTRICAL ENGINEERING

MARCH 1957
Vol. 76, No. 3

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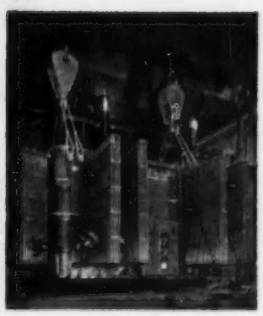

GE News Bureau Photo

THE COVER: Autotransformer rated 200,000 kva and weighing 205 tons is hoisted by crane from test bay at GE Power Transformer Department, Pittsfield, Mass. Story on page 254.

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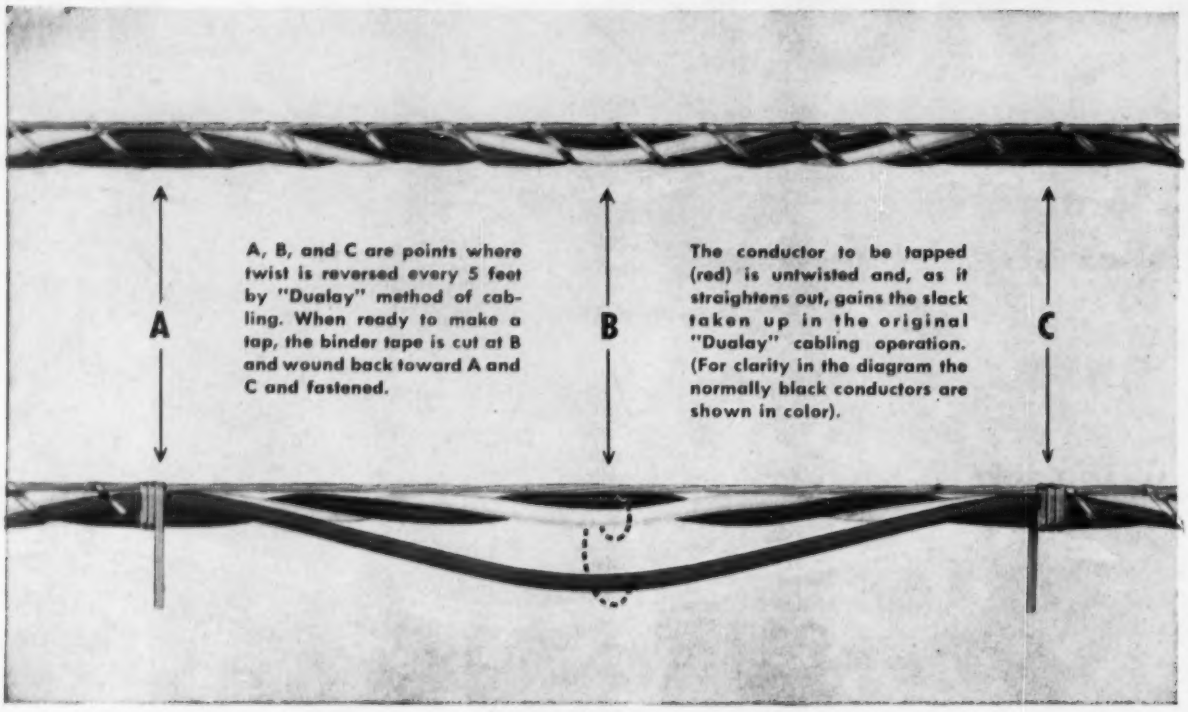
A
A, B, and C are points where twist is reversed every 5 feet by "Dualay" method of cabling. When ready to make a tap, the binder tape is cut at B and wound back toward A and C and fastened.
B
The conductor to be tapped (red) is untwisted and, as it straightens out, gains the slack taken up in the original "Dualay" cabling operation. (For clarity in the diagram the normally black conductors are shown in color).
C

how DUALAY* further reduces cost of self-supporting aerial cable

Most public utilities are fully aware of the economies of self-supporting aerial cable distribution systems. Savings are realized through ease of installation, reduction in tree trimming, fewer service interruptions, use of longer spans, and lower maintenance costs.

However, the DUALAY* assembly, originally developed by Okonite engineers and now a standard construction on all 3/c Okonite self-supporting cables up to 15kv, offers still further installation and maintenance economies.

Main feature of the Dualay assembly is that the direction of lay of conductors is reversed at regular short intervals. This permits unshielded cables to be tapped hot. (See diagram above.) The phases can be separated without cutting the copper or aluminum conductors and without performing any operation on the messenger. Design permits use of wire guards and rubber blankets for safety, and linemen can open up cable for tapping at a pole without use of a platform. Dualay assembly also prevents longitudinal or tension stress on the conductors and assures strain-free conductor splices.

Dualay assembly is available with either Okolite-Okoprene construction (strip-insulated type) or Keystone-Okoprene (extruded type). Bulletins are available on each. The Okonite Company, Passaic, N. J.

4347-A

available with either copper or aluminum conductors

***where there's electrical power . . . there's* OKONITE CABLE**

*U. S. Pat. No. 2,430,378

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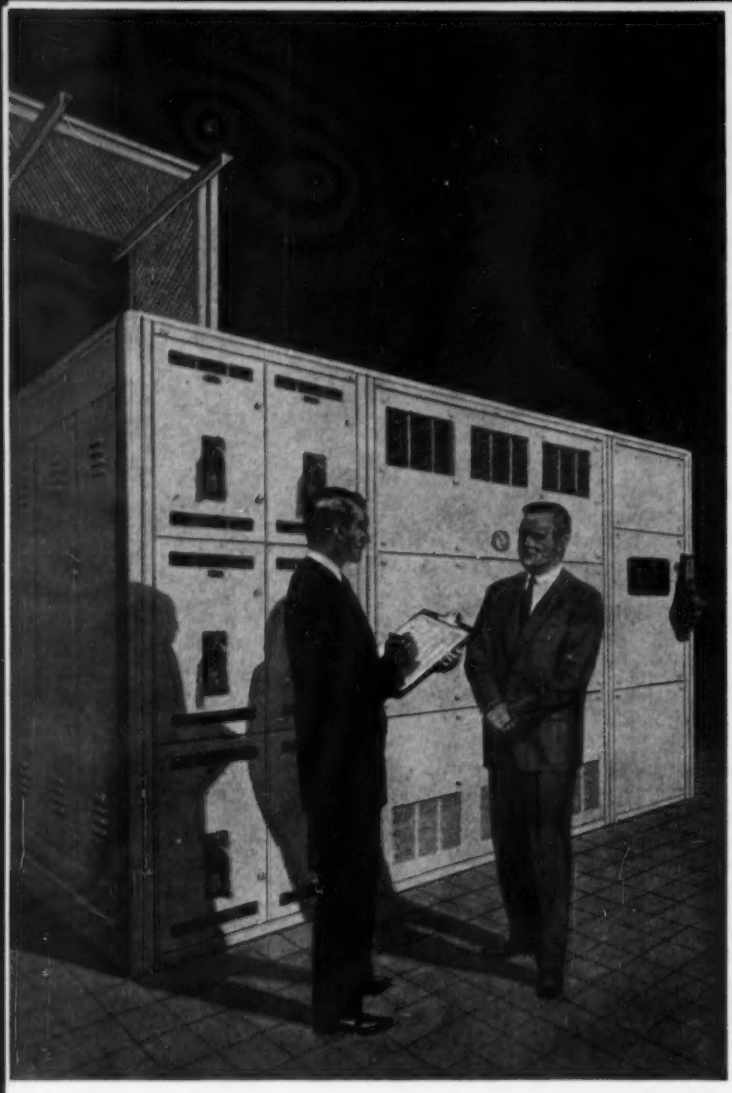

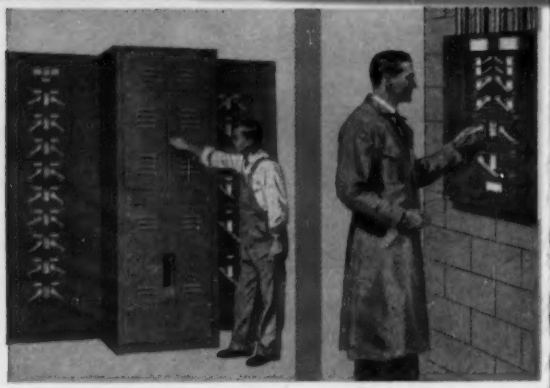

Unit-Versal® Switchboards permit additional capacity in new switches, even switchboard sections, to be added any time.

Vacu-Break® Power Panels feature interchangeable switch units. Switches are horsepower-rated, have interlocked doors.

Industrial Trol-E-Duct® feeds and supports light power tools on mobile trolleys, literally puts power on wheels!

Your BullDog Field Engineer will be happy to give you any additional facts on modernizing your power system. See him.

Power systems made to order for production increases

Expect to increase production now or in the future? If so, your electrical distribution system rates an A-1 priority. It's an area where returns far exceed outlay.

Take a BullDog distribution system, for example. All products are dependably built to perform efficiently, reduce maintenance and downtime. Designs are *flexible* so your changeovers can be made quickly and easily . . . so capacity can be added without obsoleting existing electrical equipment. From safety switches to unit substations, BullDog products are engineered to work well individually or dovetail into an integrated system that performs with top efficiency now . . . suits your requirements for years to come.

See your electrical contractor or consult a BullDog field engineer.

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IF IT'S NEW . . . IF IT'S DIFFERENT . . . IF IT'S BETTER . . . IT'S

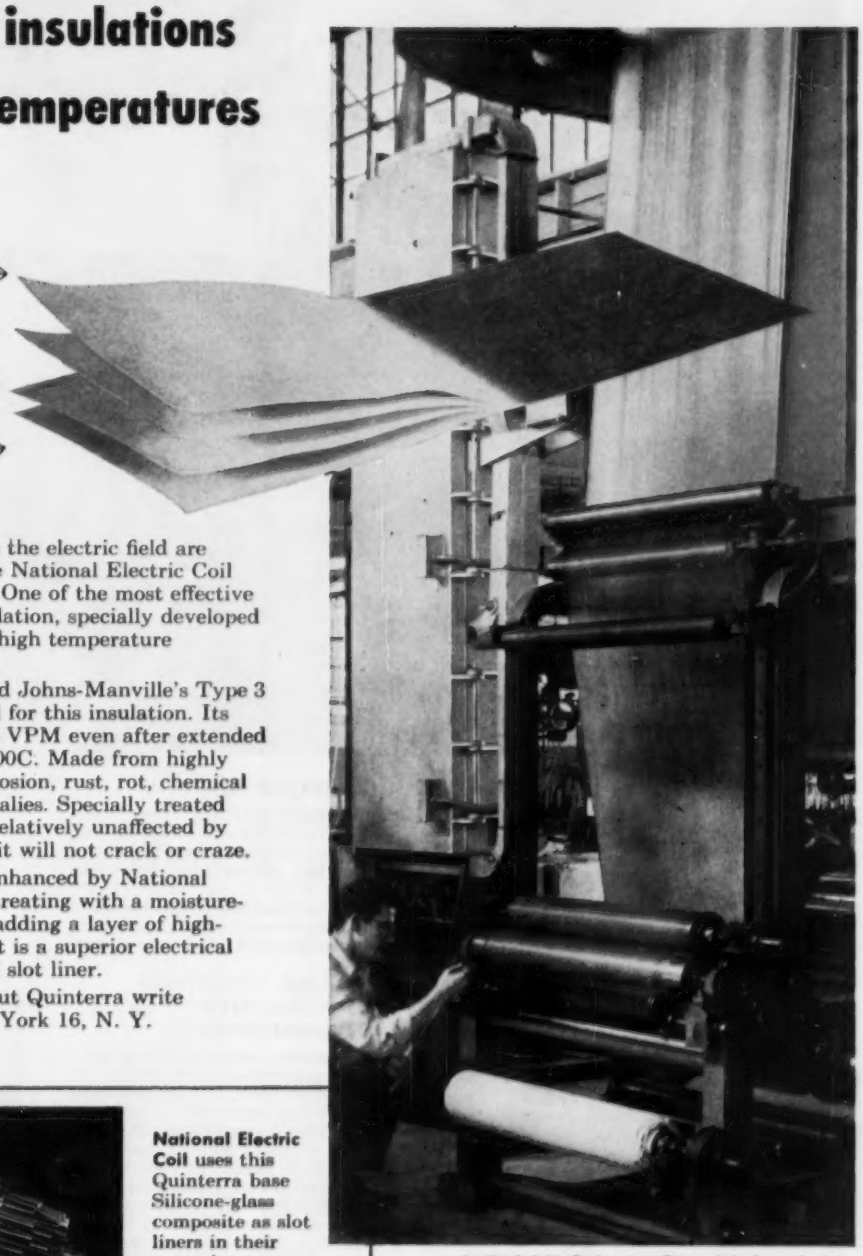
BULLDOG

ELECTRIC PRODUCTS COMPANY

A DIVISION OF I-T-E CIRCUIT BREAKER COMPANY

How National Electric Coil Co. uses J-M Quinterra®

to make their insulations resist higher temperatures



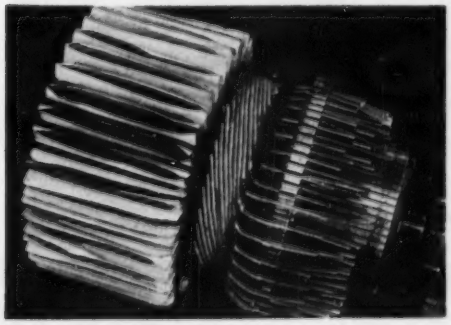
High temperature problems in the electric field are constantly being solved by the National Electric Coil Company of Columbus, Ohio. One of the most effective solutions is their Silicone Insulation, specially developed for Class H motors and other high temperature applications.

National Electric Coil picked Johns-Manville's Type 3 Quinterra as the base material for this insulation. Its dielectric strength exceeds 225 VPM even after extended exposure to temperatures of 300C. Made from highly purified asbestos it resists corrosion, rust, rot, chemical fumes, solvents, acids, and alkalies. Specially treated with a silicone saturant, it is relatively unaffected by moisture. Strong and flexible, it will not crack or craze.

These basic properties are enhanced by National Electric Coil through further treating with a moisture-resistant silicone varnish and adding a layer of high-strength glass cloth. The result is a superior electrical insulation for use as a Class H slot liner.

For further information about Quinterra write Johns-Manville, Box 14, New York 16, N. Y.

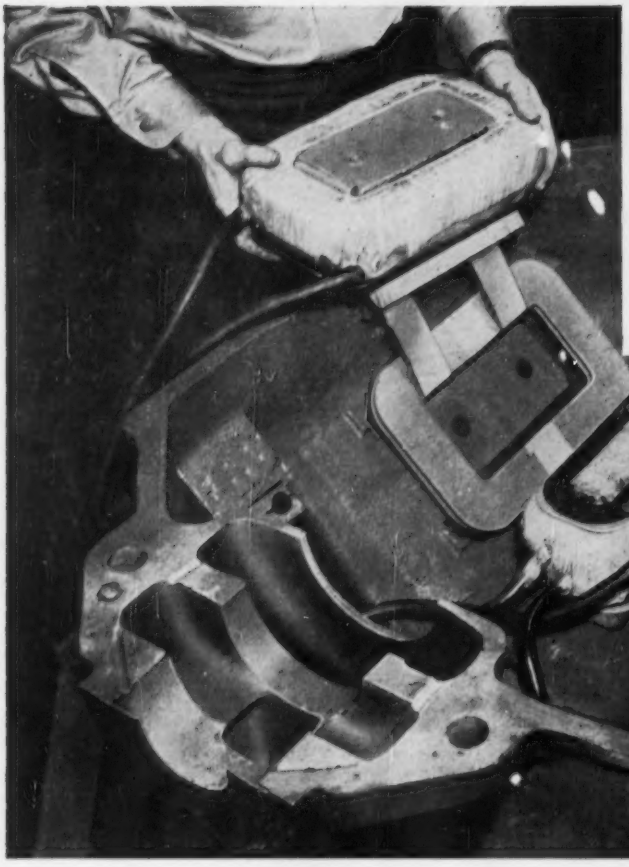
Roll of J-M Quinterra Type 3 is here being treated with silicone varnish at National Electric Coil plant.



National Electric Coil uses this Quinterra base Silicone-glass composite as slot liners in their extensive motor repair operations. It is also available to others as Catalog #8A343 from their Columbus, Ohio, factory.

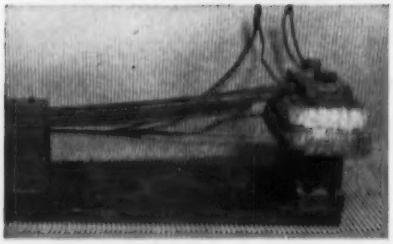
Johns-Manville ELECTRICAL INSULATIONS

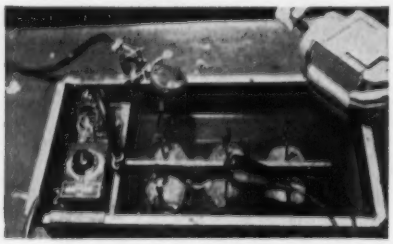
MADE OF PURIFIED ASBESTOS



for longer life and more reliable performance, use

National Polyester Moulded Field Coils





INCREASED STRENGTH

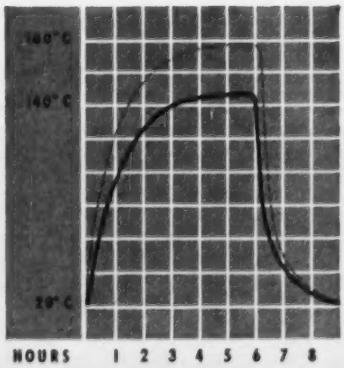
Complete polyester filling bonds all parts of the coil into a strong, unified, shock-resistant construction. The photograph at the left shows a shock test in which an energized and heated coil has been striking an anvil once a second for six months with no adverse effects.

GREATER RESISTANCE TO CORROSIVE ENVIRONMENTS

Complete polyester filling prevents penetration of moisture, oil, conducting dust, and other foreign matter that contribute to coil failures. The photograph at left shows a test in which National polyester coils were immersed successively in water, hot oil, and an iron filing solution. Periodic resistance tests show *no deterioration* of the insulation after several months submersion.

COOLER OPERATION

Absence of voids in the coil enhances heat transfer. The graph below shows comparative heating and cooling cycles for polyester-filled (solid line) and conventional varnish-treated (dotted line) field coils carrying the same amperage.



National polyester-filled field coils can be installed in National service shops or supplied for installation by your own motor maintenance crews. Call your nearby National field engineer or write for details.

NATIONAL ELECTRIC COIL COMPANY

COLUMBUS 16, OHIO, U. S. A.

TRADE MARK

ELECTRICAL ENGINEERS: MAKERS OF ELECTRICAL COILS AND INSULATION—REDESIGNING AND REPAIRING OF ROTATING ELECTRICAL MACHINES

where **POWER** is **VITAL**

ASCO AUTOMATIC TRANSFER SWITCHES help insure the safety of New York's subway millions

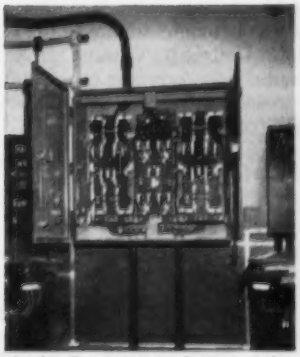
More than 4½ million commuters use the New York City subway system daily during the working week. Their safety is a major concern of the New York City Transit Authority. That is why the NYCTA insures against power failure with stand-by power. When normal power fails, ASCO Automatic Transfer Switches automatically transfer the load to the emergency source.

The Transit System's new and modern station at Grant Avenue in Brooklyn, N. Y., is typical. There ASCO switches assure continuous adequate-voltage power for a wide range of equipment: train signals, safety devices, station lighting, ventilation and drainage.

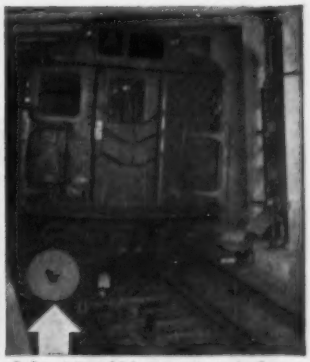
Dependable Control by ASCO

Wherever power and dependability are vital, ASCO switches provide these notable advantages: *continuous duty rating* in either normal or emergency position . . . *capacity* to withstand inrush currents 20 times full load rating . . . *rated* 750 volts A-C or D-C . . . *mechanical locking* to safeguard against vibration and electromagnetic effects . . . *single coil design* . . . *built-in time delay* so that equipment ignores harmless momentary outages . . . *full phase protection*, high thermal capacity, and many other design features and accessories. That is why safety-minded engineers specify ASCO – the one source for a full line of dependable automatic transfer switches. Write for Publication 596 on how to select an adequate automatic transfer switch.

Critical Subway equipment depends on continuity of adequate voltage power



At the Grant Avenue Station of the NYC subway system, this electrical distribution room features ASCO Transfer Switches which "throw in" emergency power for station and tunnel lighting and safety devices.

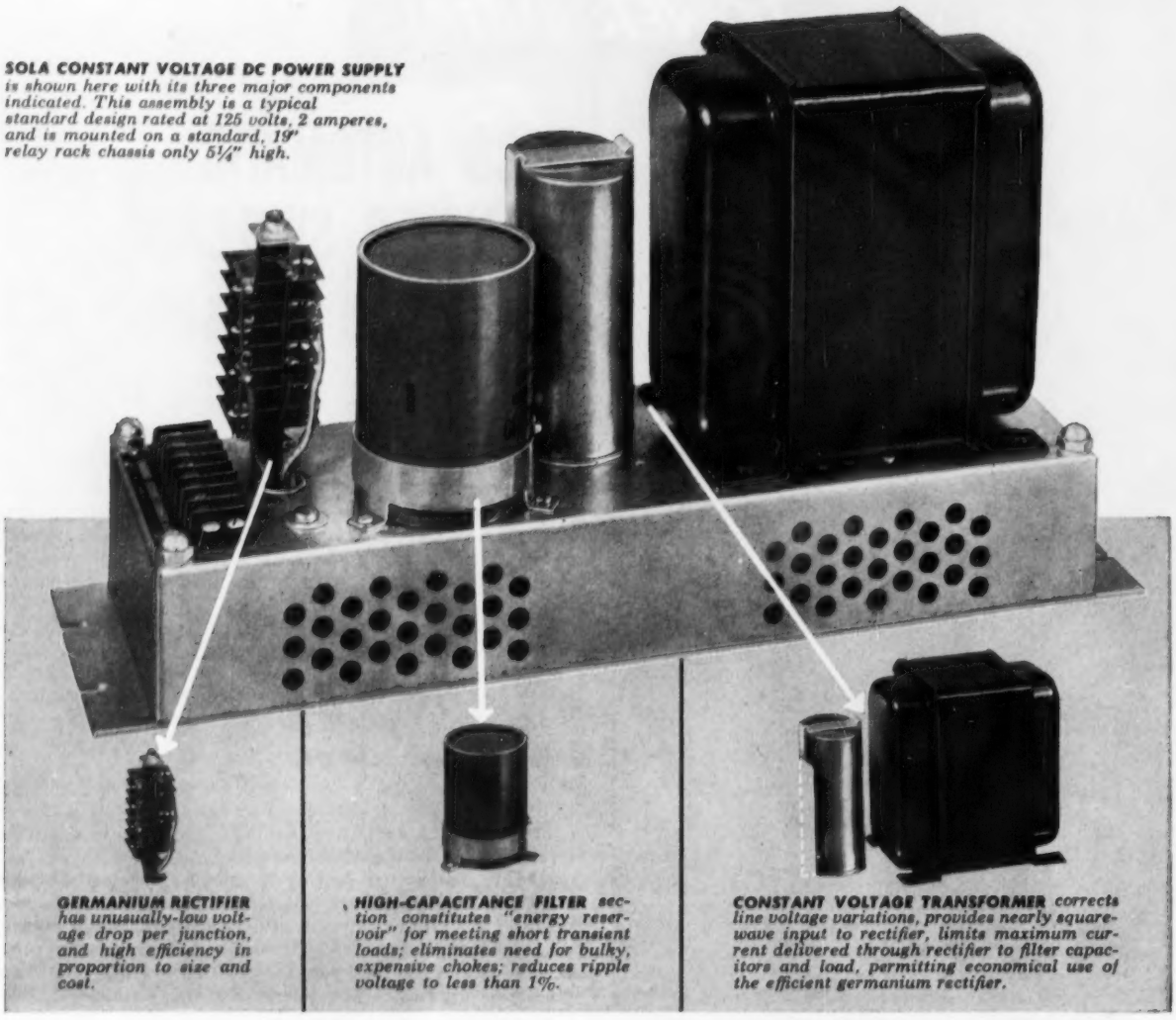


Safety trip which prevents train from passing through red lights relies on ASCO switch for emergency power.

Automatic Switch Co.
50K Hanover Road, Florham Park, N. J.

ASCO

SOLA CONSTANT VOLTAGE DC POWER SUPPLY *is shown here with its three major components indicated. This assembly is a typical standard design rated at 125 volts, 2 amperes, and is mounted on a standard, 19" relay rack chassis only 5¼" high.*



GERMANIUM RECTIFIER *has unusually-low voltage drop per junction, and high efficiency in proportion to size and cost.*

HIGH-CAPACITANCE FILTER *section constitutes "energy reservoir" for meeting short transient loads; eliminates need for bulky, expensive chokes; reduces ripple voltage to less than 1%.*

CONSTANT VOLTAGE TRANSFORMER *corrects line voltage variations, provides nearly square-wave input to rectifier, limits maximum current delivered through rectifier to filter capacitors and load, permitting economical use of the efficient germanium rectifier.*

2 amps of 125v regulated dc power in only 5¼" of relay-rack height

Exceptional performance under intermittent, variable, pulse, or high-amperage loads is a prime advantage of the new static-magnetic, Sola Constant Voltage DC Power Supply. Its design simplicity — possible because of the mutual support and protection provided by the combination of its three basic components — provides compact size, low weight, and moderate price in proportion to power output and performance.

Output of these power supplies is regulated within ±1% for line voltage variations of up to ±10%. They are available in six stock models, in ratings ranging from 24 volts at six amperes to 250 volts at one ampere. Also, design-and-assembly service for special ratings is offered to meet the specific requirements of equipment manufacturers.

Your area representative, listed below, is part of a nationwide organization maintained to provide you with prompt service. He'll be happy to supply further information on stock or special Sola Constant Voltage DC Power Supplies.

SOLA *Constant Voltage* **DC POWER SUPPLIES**

Write for Bulletin SC-CV-235
SOLA ELECTRIC CO.
4633 W. 16th Street
Chicago 50, Illinois

CONSTANT VOLTAGE TRANSFORMERS • FLUORESCENT LIGHTING BALLASTS • MERCURY VAPOR LIGHTING TRANSFORMERS
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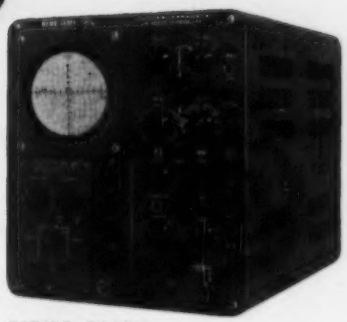
Three unusual direct-display storage tubes by Hughes

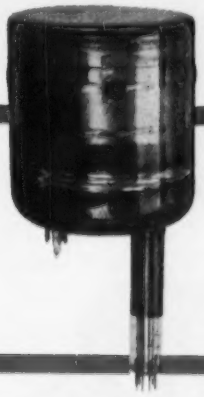
MEMOTRON

FEATURES: bright display . . . constant and uniform intensity of presentation . . . no perceptible transient decay . . . simplifies photography. APPLICATIONS: transient analysis . . . spectrum analysis . . . direct comparison of wave forms. SPECIFICATIONS: 100,000 inches/sec. writing speed . . . stores traces until intentionally erased . . . erasure triggered by push-button, or programmed voltage . . . electrostatic focusing and deflection.



MEMO-SCOPE

Model 104, incorporating MEMOTRON, is a new memory oscilloscope with 5 optional preamplifiers to satisfy the most critical production, test and laboratory requirements.



TONOTRON

FEATURES: half-tone presentation . . . excellent grey scale . . . controllable decay rate . . . compact design. APPLICATIONS: closed circuit TV . . . instrumentation . . . P.P.I. . . . narrow band, slow scan TV. SPECIFICATIONS: 1,000 foot-lamberts brightness at 10 kv . . . electrostatic focusing . . . magnetic deflection . . . . 60 lines per inch resolution . . . writing speed of 150,000 inches/sec.

TYPOTRON

FEATURES: high brightness . . . permanent display until intentionally erased . . . rapid display of printed data . . . 63 character matrix. APPLICATIONS: digital computers . . . teletype reception . . . wherever printed data must be displayed rapidly for use by human operator. SPECIFICATIONS: writes up to 25,000 characters/sec. . . . permanent storage until erased . . . almost instantaneous erasure . . . electrostatic focusing and deflection.

See demonstrations of these tubes and MEMO-SCOPE *at the I.R.E. Show, booths 2801, 2803, 2805, Second Floor. For additional information write to:*

HUGHES PRODUCTS • ELECTRON TUBES
International Airport Station, Los Angeles 45, California

HUGHES PRODUCTS

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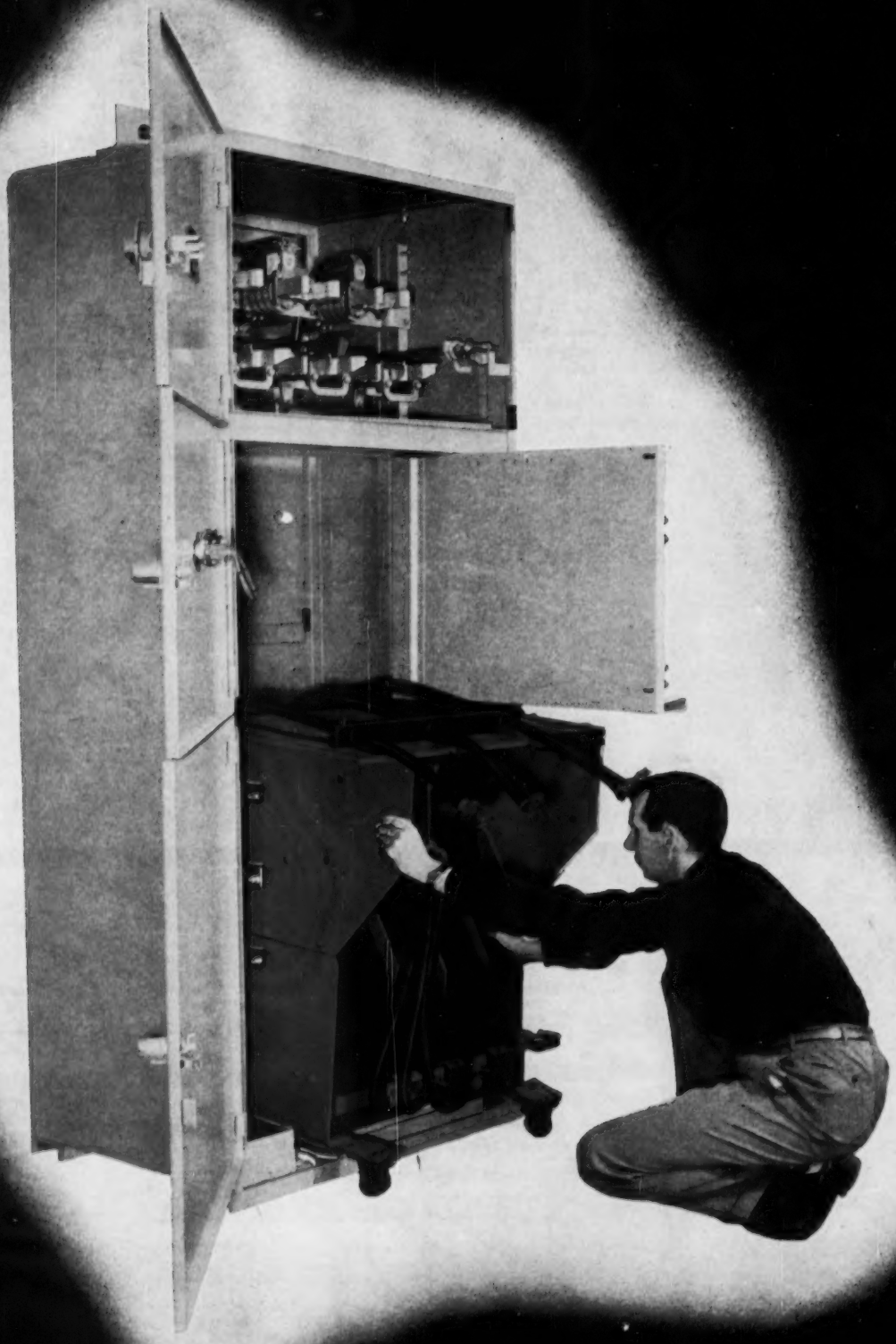
HIGH-VOLTAGE MOTOR CONTROL.....



..LEADER IN DESIGN AND PERFORMANCE

GENERAL ELECTRIC LIMITAMP* STARTERS OFFER ROLL-OUT CONTACTOR UNITS FOR EASIER INSTALLATION

Today's General Electric Limitamp starters are designed to bring you the utmost in installation ease, speed, and economy.

Key feature of this cost-cutting design is the caster-mounted contactor unit which can be easily rolled into or out of the Limitamp enclosure. After swinging out the hinge-mounted low-voltage panel, and before rolling in the contactor unit, the installation man can walk right inside the enclosure to make connections quickly and conveniently.

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MORE LIMITAMP CONTROL FEATURES

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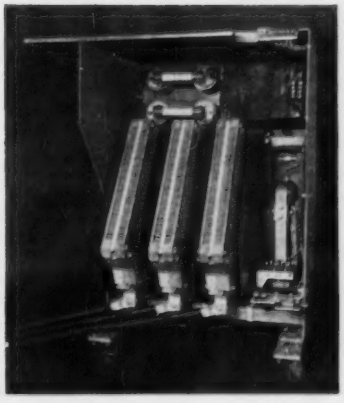
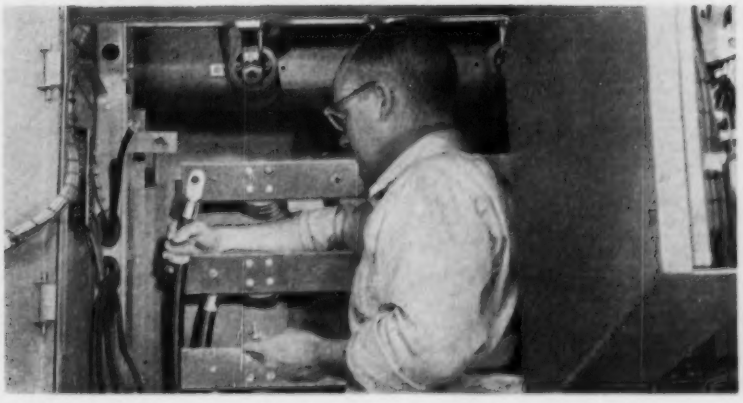


MAINTENANCE EASY on contactor; generally devices are front-removed.



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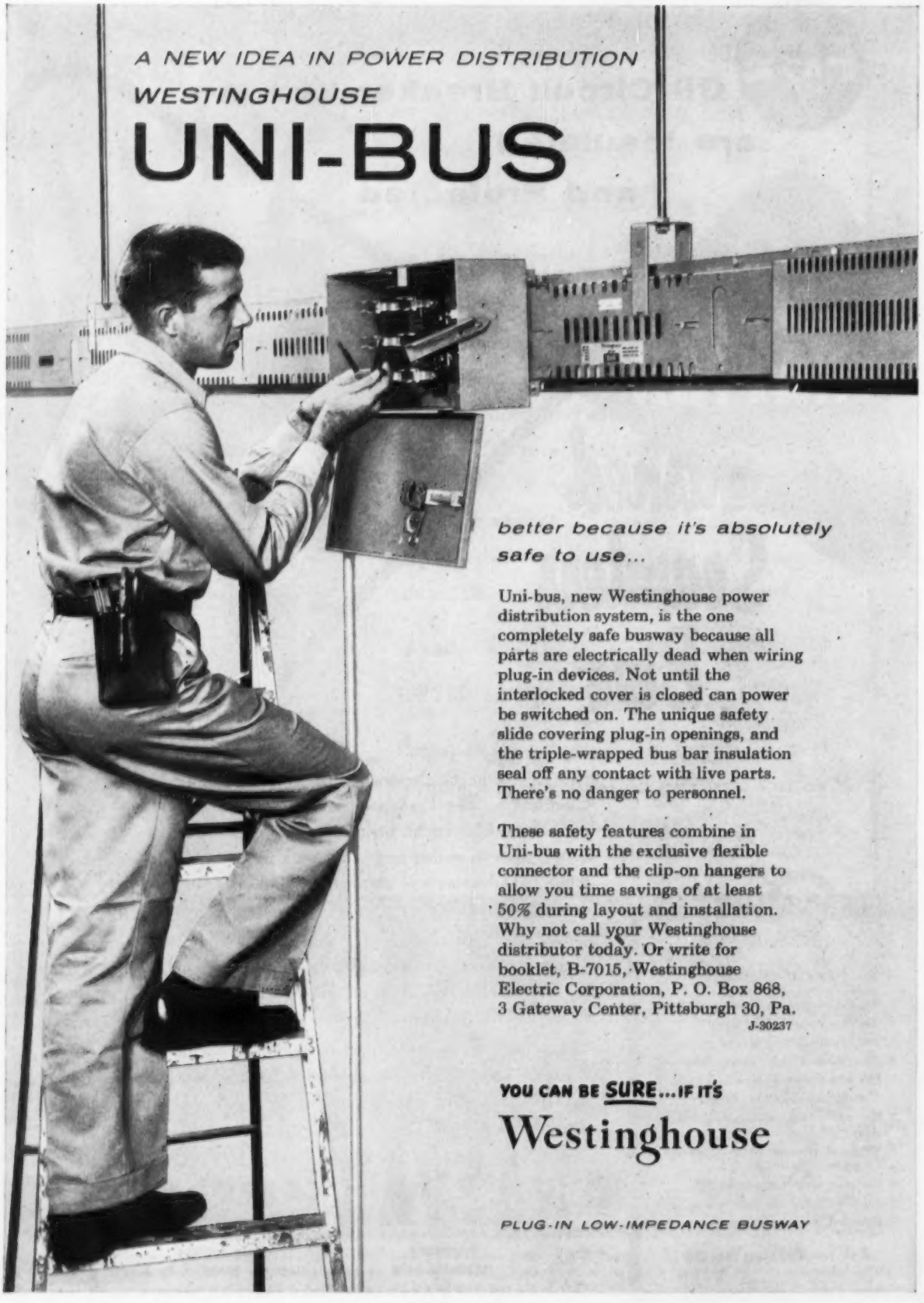

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SPECIAL TANDEM ASSEMBLIES
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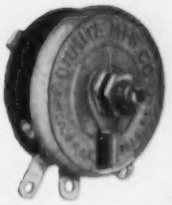
BUSHINGS FOR SPECIAL THICKNESS
Extra-long bushings and shafts for panels up to 2" in thickness. Seven bushing lengths.



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Prevents mechanical injury to rheostat or human contact with electrically "live" parts.

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Opens or closes circuit with minimum movement of control knob shaft. Extremely dependable long life switches.

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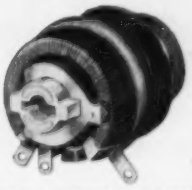
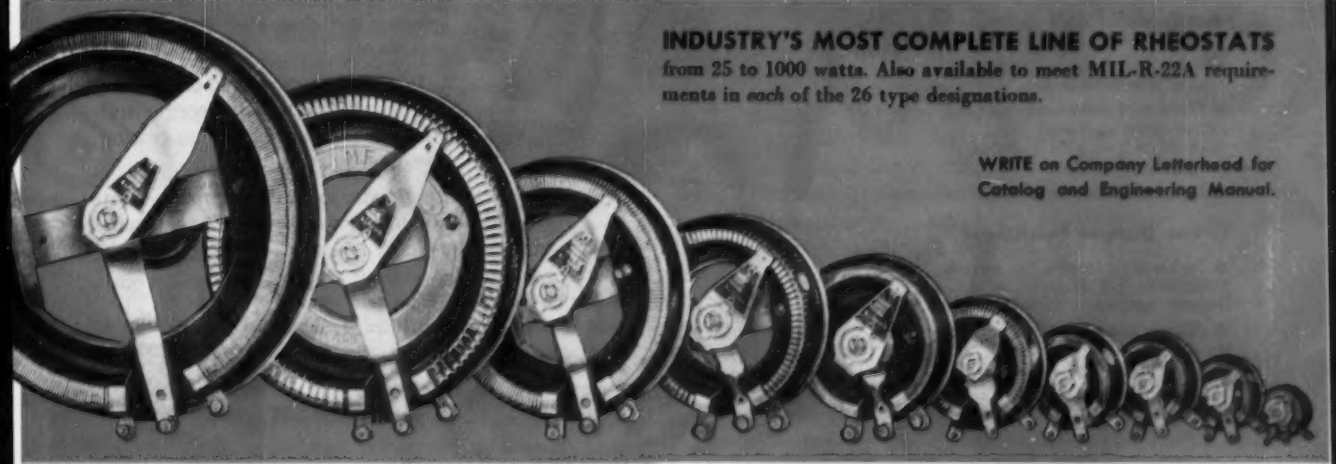


WITH OFF POSITION FEATURES
Opens circuit at high or low resistance position with *snap-action* (illus.); opens circuit at high resistance position with *dead lug* off position; or has *dead section* off position.



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The Individual

M. S. COOVER
PRESIDENT AIEE

In his address at the AIEE Winter General Meeting, President Coover emphasizes the need for more guidance in the initial education of the individual. The contribution made by the individual to the arts and to society thus will be greatly enhanced

INDUSTRY, in free nations, may be characterized by continued emphasis on production of new and better products, and also new and better methods of producing those products. Regardless of size of organization or of the products manufactured, quality springs from research, applied technology, and the integrity of those who comprise the personnel of the particular organization. Every individual associated with an organization of any kind has an influence on its future. The organization cannot remain static. Certainly, it cannot retrogress and survive. If the organization is to grow and be of service to society, the individual must contribute in some manner. This fact holds true for our Institute.

Our presence at this and other meetings of the AIEE, regardless of location, is not without meaning. It is indicative of continuing interest in the ever-expanding field of electrical engineering and associated areas. We are in attendance at this meeting, this week, because we have benefited by having attended similar previous meetings. When we profit thereby individually, so too does our employer. Progress does not come through a placid, smooth, easy-going attitude. Interest must be genuine and participation must be something other than just passive.

REPLACEMENT BY THE GROUP

PRIMARILY, since the turn of the century, the individual has been replaced by the group. This has been the inevitable transition resulting from our expanding national economy. Only what may be termed as a small business enterprise these days can be directed by a single mind. The individual is no less important than he ever was, but as the enterprise increases in size so does the amount of teamwork that is required. The larger the enterprise, the more essential it becomes to delegate authority for successful operation. Here again, the same principle applies to our Institute.

As the AIEE has grown through the years, changes in management and operation have been necessary. Our Institute will continue to grow only through being better able to render continually improved service to its members and to other professional societies through our official representatives. This we conscientiously believe we are doing. Principal among recent adjustments may be mentioned the rewrite of our Constitution and By-Laws providing for five operating departments, the creation of a new technical division, now six in number, and numerous minor changes. These have been reported to you in our excellent monthly publication. Experiences that are being gained this year in operating the Institute under the new administrative structure gives evidence that some further adjustments can be made to advantage. These adjustments are under consideration.

There are many items of current interest which I would like to direct to your attention. Time simply will not permit my indulgence. However, the information that I particularly have in mind is spread upon the pages of the current and subsequent issues of *Electrical Engineering* under "Institute Activities." I urge you to acquaint yourselves with those items which pertain to the welfare of the Institute, if you have not already done so.

EDUCATION

ONE SEGMENT of our Institute has to do with education. An educational institution could be considered analogous

Full text of an address presented at the General Session of the AIEE Winter General Meeting, New York, N. Y., Jan. 21-25, 1957.

M. S. Coover is administrative assistant, Division of Engineering, Iowa State College, Ames, Iowa.

to an industry in that it turns out a product. To do so requires management, and if management is aggressive and progressive, that educational institution will strive constantly to improve its "product" by readjustments in its methods of production, even if the incoming "raw materials" are lowering in quality.

If one were to take a moment of serious reflection and confine it to the events of the last 20 years, he will realize the astounding acceleration in the advancement of technology. The rate of acceleration seems destined to increase further, and to be unprepared to meet this challenge has implications closely related to national survival. Fundamental revision must take place in all curriculums in science and in engineering, particularly at the undergraduate level in our colleges and universities. The time is upon us when we must break with tradition and eliminate vocational types of courses. Those courses now belong to technician training programs. The abundance of new material, design of new products, development of new processes, process controls, instrumentation, complex circuitry, computers, and many other components of industry and businesses have increased the need of higher levels of competence on the part of graduates in science and engineering. It becomes imperative that methods be developed whereby those high levels of competence can be reached successfully. I believe that our colleges and universities realize their responsibility in this regard. One of the major obstacles is that the lure of industrial salaries with their accompanying benefits is rapidly depleting our colleges and universities of quality teachers. Replacement is becoming more difficult and at the same time more potential students are seeking admission.

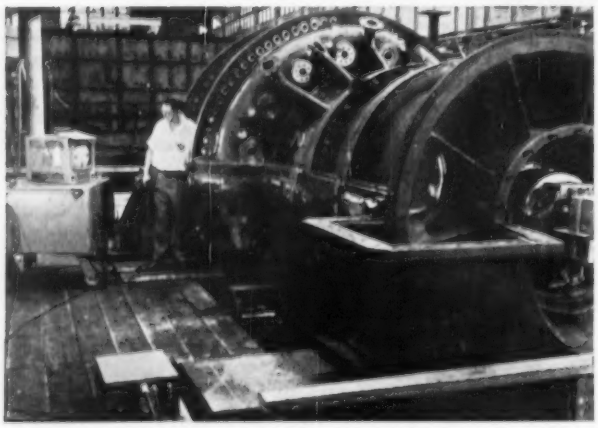
Also, of equal concern is whether adequate preparation is being made for admission into our colleges and universities. Here too it is possible to locate reasons for conditions that exist. No one disclaims the advantages of a good health program, hence, one seldom learns of a voice being raised against improvement in athletic facilities at the high schools even though it is at the expense of facilities for more valuable fundamental training. Economic circumstances have lured too many good high school teachers to other employment. Without proper guidance, particularly at home, potentially capable high school students can drift into the more glamorous courses that are being offered currently. All to often, parents leave guidance to teachers, and serious-minded capable counselors seems to be rare. An ever-widening abyss, thus, is being created between high school terminus and college entrance requirements.

We in the United States believe in local control over education. It can be made to work properly. Unfortunately, school administrators in some communities acting with good intentions based on inadequate information, or yielding to pressure from those who would spare their children from the more rigorous courses in the sciences have permitted the quality of those courses to decline or, except for mathematics, to disappear. To reverse this trend is neither easy nor inexpensive. Let me repeat that the problem of the widening abyss between high school terminus and college entrance requirements is acute and it is tragic. It seems incredible that we can think of continuing to have a well-integrated educational system without taking immediate steps to reduce that gap.

EVALUATION OF TRENDS

As ENGINEERS and as parents and as citizens who are deeply concerned about the future of our nation, we need to evaluate trends in educational standards in our own communities very carefully. This is an individual problem for each of us. We need to realize that the time is upon us to develop a corrective program wherever needed and to take action before the burden becomes too great. No burden is too great to bear if it contributes to national preservation. The gift of educational opportunities for our youth is ours. It is our responsibility both individually and collectively to make the best use of this heritage.

Closed-Circuit TV Used in Turbine Production



A General Electric Company "Intratel" closed-circuit television camera is being used to position 4- to 5-ton sections at the company's gas turbine department.

When lining up the shells, the camera is bolted, leveled, and centered on the first shell. When another shell is to be attached, a target is centered in the new shell and the camera lens focused to the known distance to the target. By watching the monitor, some 15 feet from the camera, the operator can note the target location in relation to the camera lens, thus permitting careful adjustment of the shell-connecting bolts and alignment of the new shell.

The unit being assembled is the largest gas turbine in the Western Hemisphere. It is rated 16,500 kw and will be installed in Monterrey, Mexico.

The Aristocracy of the Engineer

H. T. HEALD

In today's world, the scientist and engineer need to stand as intelligent, liberally educated men regarding knowledge as a particularized competence which, in their general wisdom, can be shared with the rest of society.

YOU ARE CONCERNED in this annual General Assembly of the Engineers Joint Council (EJC) with a re-evaluation of engineering in our society, with its place and importance, its opportunities and obligations, its impact on national and international affairs, and their impact on it.

Now is the appropriate time for such a reappraisal. Never before has the engineer been so concerned about his profession. More importantly, perhaps, never before have the people of the United States been more concerned about engineering in general. Mainly, this is because people believe there are not enough engineers.

SHORTAGE OF ENGINEERS

AMONG THE CRIES OF ALARM in our country today, few are more shrill and insistent than those concerning the shortage of engineers. Perhaps some of us, secretly, feel a small thrill of pleasure at this evidence of our value to society. It is something we have been trying for years to point out—with appropriate modesty and, until recently, with a conspicuous lack of success.

Now, however, there seems to be a convergence of our own strong effort to clinch the status of engineering as a profession, and the nation's discovery of its overwhelming need for engineering talent. We can appreciate the recognition, but we cannot be complacent about the obligation it imposes upon us.

Industry's eager and even desperate appeals for engineers of one kind or another fill a good many pages of the Sunday newspapers. Some employers estimate that they are now spending as much as $1,000 in advertising for each engineer they recruit. One industrialist, tired of competing for engineers, simply bought up a company full of them.

And, if we look over our shoulders at the USSR, as we do reflexively these days, most of us are dismayed to see phalanxes of engineers, scientists, and mathematicians pouring out of Soviet schools, suggesting that our own pre-eminence in these fields is sorely threatened.

William Benton, after his trip to the Soviet Union, reported that the output of engineers in the Soviet Union had increased by some 1,300% (per cent), a rate of expansion 10 times greater than in the United States; and that the number of engineering graduates from institutions of higher learning has more than doubled in the last 5 years, while the number here has declined by more than half.

You are all aware of the many studies that have been made and the statistics that have been compiled. They are impressive or frightening depending upon your own viewpoint. The position of the United States in a troubled world cannot be assessed adequately without an intelligent awareness of Soviet plans and progress.

I do not take either our shortages at home or the Soviet advances lightly. But I wonder whether either problem is quite the main problem.

THE REAL PROBLEM

OUR REAL PROBLEM NOW, as it has always been, in medicine, in law, in the natural and social sciences, as well as in engineering, is to produce an adequate supply of high quality people and utilize them properly.

By "adequate supply," I do not mean the largest number of engineers we can create quickly, but a variable number determined by factors which are themselves variable with time, place, and the ever-changing needs of our economy and society.

By "proper utilization," I do not mean the use of engineers in positions which require routine skills that can be performed by other more numerous, less skilled technicians but in positions which demand the highest level of thought, ability, and performance.

Neither the shortage at home nor the increased output abroad are reasons for futile fright. We ought to be concerned about engineering numbers and quality regardless of what the USSR does. We can hope that other countries, too, will improve engineering education, for the emerging, independent, underdeveloped countries of the world need all the engineers they can get.

Quality and quantity are not mutually exclusive terms. Nor should we be misled by an involvement with sad statistics. We must, I believe, be concerned with three continuing efforts; first, to utilize better the supply of available talent; second, to provide better educational experience for future talent; and third, to improve our methods of identifying potential talent that might otherwise to be lost to us and to provide educational opportunity commensurate with ability.

Our concern, in short, would be to appraise our own needs and requirements and, as a profession, to measure up to the performance standard the public has a right to expect of us. If, on this basis, we wish coincidentally to compete with the Soviet Union, there will be point and purpose to the competition.

Essentially full text of an address delivered at the Annual Dinner of the Engineers Joint Council, New York, N. Y., January 17, 1957.

H. T. Heald, civil engineer, is president of The Ford Foundation, New York, N. Y.

APPRAISAL OF NEED

My emphasis on quality and on utilization is not an abstraction or an unattainable ideal. It is a way of saying that the evolution of professional standards must be shared by many people. It must involve parents, who kindle the initial flame of interest; the high schools, which nurture the love of learning; the colleges, where excellence of education is the main goal; industry, Government, and the military services, which are the consumers of engineering talent; and, above all, the members of the profession themselves, who set the tone, establish the objectives, achieve the perspective, and jealously guard and constantly upgrade the standards of the profession.

The professional obligation is particularly difficult, for engineers and engineering organizations contain so many different kinds of people who are involved in tasks that vary greatly. What is engineering, anyway? Is it a profession? A way of life? Or a conglomeration of people with somewhat similar backgrounds who are employed in a variety of ways in business, in Government, in teaching, and in research?

Today engineering and its subdivisions and off-shoots are active everywhere, from planning, production, and distribution to highly creative innovation and research.

Activities of engineers run the gamut from relatively routine, but nonetheless important, tasks to those involved in the endless search along the ever-widening frontiers of knowledge. Increasingly, engineers are engaged in high level corporate management, and in determining public policy in local, national, and international affairs. In this diversity we cannot afford to forget, or submerge, or lose sight of the common concern for excellence.

Engineering in its diversity has become somewhat like medicine; that is, the majority of its practitioners work with the knowledge and use the techniques developed by others. Relatively few engineers are in the research laboratories working on fundamentals, developing new principles, testing new concepts, solving perplexing basic problems, defining new ones.

Without in any way disparaging the day-to-day practitioners—the managers, the operators, the people who keep things going—the real and vital need is to find and encourage the relatively small number of high quality creative people required to produce the fundamental knowledge that others can apply and to supply the leadership which really determines the character of any profession.

Furthermore, it is in this area that engineering is most inadequate and quite unlike medicine. Most of the basic research in the biological sciences is conducted in medical schools or in institutes associated with medical schools. But the bulk of engineering research is conducted away from the colleges and universities. Industrial laboratories draw off too many of the good people. We can blame this on better salaries, better equipment, fringe benefits, or other factors; but could it not be also that incentive is lacking for the real pioneer mind, that engineering is not sufficiently fundamental and has not related itself enough to the basic sciences? Perhaps our engineering schools have not yet fully accepted their role as places where new knowledge is to be developed.

REMEDIAL MEASURES

We must put more emphasis on graduate and postgraduate education and on research opportunities for those who have the inclination and the ability. The emphasis on fundamental knowledge is logical and natural in the growth of a profession. Unless the supply of fundamental knowledge is constantly replenished, there is nothing to apply.

This is a serious national problem. Its ramifications are important to our economy, to national defense, to the welfare of our people. It is a matter of high import to our Government and to many thoughtful citizens. It is a concern of philanthropic foundations, and it is a subject to which The Ford Foundation will give more attention.

The future of engineering is in the pursuit of creative ideas. This kind of activity does not come en masse. It comes from a handful of men. And these must be the quality few. I am reminded of an address by the late Grove Patterson, for many years a distinguished Ohio newspaper editor, in which he said:

> "America's number one need is an aristocracy. I believe in the democracy of opportunity, but I believe in the aristocracy of achievement. Thomas Jefferson and the Declaration of Independence do not support the idea that human progress is by way of equality. It is by way of quality."

In his remarks Mr. Patterson made a plea for personal responsibility among what he called "the members of this new aristocracy." He listed four essential characteristics for them: the capacity for thinking, the capacity for a new courage, the capacity for great imagination, and the capacity for a faith greater than they have ever had before. These also are the essentials of the aristocracy of the engineer.

The engineer, in considering the future of his profession, should not forget that others, too, are concerned about engineering and about their own futures. The humanists are worried about the encroachments of science. The liberal arts enthusiasts are fearful lest the major emphasis shift to engineering and science, and leave them alone in an educational wasteland.

It would be unfortunate indeed if this should occur but it is time to allay once and for all the notion that the engineer must be a narrow, inarticulate specialist who cannot see beyond his slide rule and somehow is inferior to his brothers who have sampled the liberal arts. It is equally unrealistic to assume that every liberal arts graduate, just because he is a liberal arts graduate, is therefore wise and fully educated and superior.

The humanists are just as concerned about their future in society as are the engineers. J. P. Corbett, the Oxford philosopher, recently stated that "the citadel of the

arts has been besieged and infiltrated by forces of a new and alien kind."

> "The great mass of our education is going to be scientific, not only because we need the research and the applications of research but because, if science is to be exploited economically on the scale and with the vision that is required, there must be far more understanding of scientific methods and concepts than exists at present amongst educated people. The arts must therefore change, or die."

Two other quotations by Mr. Corbett are equally pertinent: "Scientific civilization," he says, "is not only revolutionary and brand new, it is world-wide, the first civilization to be common to every race of man." And again, speaking of Oxford University and education in general: "We should be teaching young people to think about the world, not to talk themselves out of it; to work through concrete problems of nature and society, not to drop a verbal curtain between those problems and themselves."

THE CHALLENGE TO EDUCATION

He concludes by throwing out the challenge to his fellow humanists to change their ways, to take account of the scientific world, to combine its values with those of the traditional liberal arts pattern. I suggest that he has also challenged engineers and scientists. For any liberally educated person today ought to know something about science just as any scientist or engineer ought to know something about society. Neither can be called educated if ignorant of the other's field. And any educational system for one is inadequate if it takes no account of the other.

The scientist–engineer from now on must be a broad, liberally educated person, capable of examining and evaluating the proportions of society as well as the riddles of nature, of providing the leadership of ideas without which there is no meaningful progress.

Scientists and engineers, no less than doctors, lawyers, or the managers of industrial enterprise, need to stand as intelligent, liberally educated men, regarding their knowledge not as a narrow, isolated specialty but as a particularized competence which they, in their general wisdom, can share with the rest of society.

The permanent strength of engineering lies in its ability to respond to man's hope for a better life. People all over the world, who for generations have lived in poverty and degradation, are crying for technical enlightenment by which they can lift themselves from misery, realize their dignity as men and, by so doing, add also to their spiritual stature.

Society needs not only highly qualified engineers, but also men of high standards and great potentialities of all kinds. No degree of specialization is an adequate substitute for the broadly cultivated mind. Engineering competes with other professions and callings for the best. Let us settle for nothing less. Let us give engineers the best, the broadest, and the most liberal education we can devise. Let us find ways to inspire them to great effort and, therefore, great accomplishment.

This will not be easy. It will require patience, understanding, and intelligence, and above all, high goals and extraordinary effort. But, if we do these things, we shall find our shortage of engineers less severe and our concern for Soviet accomplishments less worrisome; and we shall have made engineering a better profession and we shall have served society more fully.

The Case for a Standard System of Electrification for American Railroads

T. F. PERKINSON
MEMBER AIEE

Some of the more important aspects of system standardization for main-line railroad electrification in the United States are discussed. Investigation has shown that the commercial-frequency system appears to have enough advantages to justify its recommendation for American railroads.

FOR MANY YEARS electric-traction engineers have been aware of the advantages that would accrue with system standardization in the heavy electric-traction field, but for various reasons the recognition of a uniform contact system as a standard for main-line electrification is as yet a goal to be attained.

Recent developments in a-c single-phase motive power and widespread activity in railroad electrification matters outside of the United States, in which activity the use of commercial-frequency a-c power is playing a prominent part, are encouraging domestic railroads and manufacturers to consider the possibility of adopting a standard system for future electrifications in this country.

The reason for seeking a single standard system for main-line railroad electrification are not so compelling as

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those that brought about the standardization of the track gage. Under the present system of privately owned and independently operated railroads, relatively little interchange or interrunning of motive power between systems takes place, and in most of the few instances where circumstances require such interrunning, it is readily accomplished with self-propelled vehicles—either steam or diesel-electric locomotives. In a few cases, interrunning of electric rolling stock does occur and, incidentally, serves to emphasize the advantages of a common, uniform contact system on the one hand, and the disadvantages involved with nonuniform power-collecting systems on the other.

MANY SYSTEMS DEVELOPED

Unfortunately, at least from the viewpoint of standardization, there are several different systems available and highly developed by which electric traction can be provided. Each of the systems has its points of superiority —and inferiority—and because of and in spite of these characteristics, each is able to perform the task of providing train motive power with a high degree of performance, reliability and relative economy. Tables I and II indicate the multiplicity and variety of systems operating throughout the world today.

Where local conditions have been governing, the peculiar characteristics of one system in some cases have given this system some advantage over the other, and because there was no impelling reason for modifying the governing local conditions to utilize a standard system when electrification was undertaken, the system most closely fitting the existing conditions was generally adopted.

In some instances where electrification had to be adopted, any one of several systems could have been employed with substantially equivalent results, but inasmuch as there was no commonly recognized standard, the decision of system selection was made by committee or commission agreement, by consultants retained for the purpose, or by individual engineers in the employ of the railroad. In each case, the agency making the decision advanced technical, economic, or other arguments to demonstrate and prove to management the wisdom of the selecion.

DETERRENTS IN THE UNITED STATES

Probably the greatest deterrent to the establishment of a standard for railroad electrification in the United States is the understandable absence of general interest on the part of the railroads in the matter—a condition traceable to the development and adoption of the diesel-electric locomotive on a revolutionary and wholesale basis, and to the downward revision of the railroad's position in the over-all transportation industry.

Underlying both of these events is the internal-combustion prime mover: the diesel engine and gas turbine in railroad motive power, and the gasoline, diesel, turbine, and jet engines in the airplane, bus, and private automobile. All of these prime movers now in current use depend on liquid fuels, and as long as such fuels are economically available the self-contained, self-propelled transport vehicle will be the preferred means for moving materials, goods, and people for a major portion of the transport industry.

Self-containment, with resultant mobility and flexibility, accompanied by reasonable economy of operation and facility of acquisition from the financial as well as physical standpoints, are the features that enable the diesel-electric to hold its dominant position in the railroad motive-power field today.

There are, however, some segments of the railroad transportation activity where self-containment is of less importance than are superior performance and economy of operation. There is little or no valid contradiction to the statement that electrification provides superior performance in railroad motive power, but there are economic reasons for precluding consideration of electrification in many cases. Among these reasons first costs and fixed charges are dominant.

Adoption of a standard system, involving a minimum of fixed-facility initial costs, would combine to expand the sphere within which electrification would be economically competitive with or even superior to existing forms of self-contained motive power. This system, at the same time, would permit the use of low-maintenance, moderately priced motive power having developmental potentialities that point to lower costs as extended production ensues.

With the desirability of system standardization established, the question then arises as to which system, or possibly systems, should be selected as the standard.

EARLY D-C SYSTEMS DEVELOPMENT

Commercial electric traction in the United States had its inception in the street railways, and in this application a high degree of standardization was realized practically from the beginning, in that the nominal 600-volt d-c system was almost universally employed. Occasionally, an experimental installation was made in which a higher voltage was employed, generally where the urban transit system was integrated with an interurban operation in which the greater distances run made higher voltages than 600 desirable and economical.

As the interurban electric railways developed, the limitations inherent in the relatively low voltage of 600, particularly the disadvantages of excessive voltage drops and their effects on equipment performance, led to the development of higher voltage d-c systems, and the use in some instances of still higher voltage a-c systems.

Interurban electric railways utilizing 1,200 volts d-c on the contact system came into common usage in the years around 1910, and these were followed in the mid-1910–1920 era by short-lived experimental installations carrying 2,400 volts on a third-rail contact system, and another carrying 5,000 volts on an overhead trolley wire.

The 2,400- and 3,000-volt systems with overhead contact systems were developed for heavy main-line railroad traction service in the same period, and the latter appears to be the maximum nominal d-c voltage which has been successful and capable of commercial survival.

THE "BATTLE OF THE SYSTEMS"

While the advocates of the d-c system were reaching toward higher voltages, proponents of the a-c systems were developing these, with the inevitable resultant "Battle of the Systems" coming into being.

Proponents of the a-c systems emphasized the superior transmission–distribution characteristics afforded by high voltages made practical by the a-c transformer. The penalty for securing these admittedly superior characteristics was exacted by the necessity of using less satisfactory and more costly motive power.

The d-c system advocates stressed the superior characteristics of the series-wound d-c traction motor, which permitted the use of less costly (from the initial and operating standpoints) motive power, with generally superior performance characteristics.

A-C SYSTEM DEVELOPMENT IN THE U.S.A.

The 11,000-volt 25-cycle single-phase system came into being in 1907 with the electrification of the New York, New Haven & Hartford Railroad's lines adjacent to the New York terminal area and with the electrification of a short interurban line of the Erie Railroad between Rochester and Mt. Morris, N. Y. The latter may be considered as the first commercial-frequency electrification of any significance in the United States, because the line was powered through Scott-connected transformers fed from the 3-phase 25-cycle commercial power supply system of the Rochester area.

In only one instance has a greater voltage than the nominal 11,000 been utilized on a heavy-traction electrification in the United States. This was on the 22,000-volt 25-cycle single-phase electrification of the Detroit, Toledo and Ironton Railroad, an electrification that was abandoned in 1929.

It is of interest in passing to note that the first main-line railroad electrification in this country—the Baltimore & Ohio's Howard Street Tunnel and Belt Line in Baltimore, Md., in 1895—was operated at 600 volts. It was the only electric traction system that had been commercially developed at the time.

EUROPEAN DEVELOPMENTS

So far as European developments are concerned during the early days of electric traction, the experience with d-c systems paralleled closely that in the United States and does so today. The development of the a-c system was, by force of circumstances, somewhat different inasmuch as Europe had no extensive 25-cycle industrial power installations and had adopted at an early date, a frequency of 500 cycles as a standard commercial-system frequency. In developing a-c electric traction it seemed logical to adopt a frequency which was an even fraction of the commercial or industrial frequency for two principal reasons, *viz.*, the provision of frequency ties between the traction system and the commercial power sources was facilitated by the 3-to-1 frequency ratio adopted, and the design, manufacture, and operation of single-phase series-wound traction motors was materially improved with the use of the relatively low frequency of $16\frac{2}{3}$ cps. Simultaneously, contact system voltages of the order of 15,000 to 16,000 volts were adopted, a limit probably dictated by practical line-to-ground clearance and insulation considerations.

SALIENT FEATURES OF THE TWO SYSTEMS

Both systems—the high-voltage d-c and the higher-voltage a-c versions—have their points of superiority.

The d-c series-wound motor is generally acknowledged to be the best available type of motor for traction service, but its commutator sets a practical maximum voltage that can be applied to the motor without incurring undue maintenance costs and sacrifice of reliability in performance. The lack of a practical d-c transformer, or its equivalent, restricts the contact-system voltage to a maximum that can be accepted directly by the traction motors in practical control combinations. This has, so far, imposed a ceiling of nominally 3,000 volts for d-c systems. This voltage requires substantial conductivity in the contact system, and the conductor requirements with supporting structures are appreciably greater than for the higher-voltage a-c systems.

A prime power supply of alternating current and the use of series motors taking direct current directly from the contact system require wayside conversion equipment which may be motor–generators or static rectifiers, both of which involve significant first and operating costs.

However, there are many 3,000- and 1,500-volt systems in use and performing successfully in many parts of the world. These systems seem most practical when employed on relatively lightly trafficked lines where large amounts of energy in single blocks are not required for normal operations. They are also in successful operation in multiple-unit suburban operations where distances are short but train density is relatively high, especially during rush-hour periods. Under very heavy loading conditions involving heavy train operations, either large quantities of contact-system conductors or frequently spaced high-capacity conversion substations will be required. Thus, for the "heavy" railroading of the type found in many of the American operations, the first costs of distribution and conversion equipment would be materially increased.

Low-frequency a-c systems in general use today require either low-frequency prime-power generating or frequency conversion through relatively costly and power-consuming frequency changers. In addition, special single-phase transmission lines are needed to supply the special wayside transformer substations involved.

While the low-frequency series-wound a-c traction motor has been developed to a degree of high reliability and successful performance characteristics, its initial and maintenance costs aspects have always been inferior to those of the d-c motor, and particularly to those of the low-voltage d-c motor. The problems of commutation in the a-c series-wound motor are troublesome, not only in the case of low frequency, but also, to an even greater degree where the motor is required to operate at the higher commercial frequencies of 50 or 60 cps.

THE COMMERCIAL-FREQUENCY SYSTEM

The developments and improvements in the mercury-

Table I. System Voltages, Frequencies, Phases for A-C Systems

A. Other Countries

Voltage	Phases	Frequency, cps	Where Used
25,000	1	50	France, Turkey, Portugal
20,000	1	50	Germany, France, Belgian Congo
16,000	1	15	Sweden, Norway
16,000	1	16-2/3	Sweden
16,000	1	25	Sweden
15,000	1	20	Costa Rica
15,000	1	15	Germany
15,000	1	16-2/3	Austria, Germany, Italy, Switzerland
15,000	1	50	Hungary
11,000	1	16-2/3	Switzerland
10,000	3	45	Italy
10,000	1	16-2/3	Norway
10,000	1	25	Sweden
6,600	1	50	England
6,600	1	25	England
6,500	1	25	Austria
6,000	1	50	Germany
6,000	1	25	Germany, Norway
5,500	3	25	Spain
3,700	3	16-2/3	Italy
3,600	3	16-2/3	Italy
3,300	1	25	Canada
750	3	40	Switzerland

B. United States

11,000	1	25	

Used on Pennsylvania Railroad (locomotives and multiunit cars)
Reading Railway System (multiunit cars)
New York, New Haven & Hartford Railroad (locomotives and multiunit cars)
Virginian Railway (locomotives)
Long Island Railroad (locomotives)

arc rectifier, and the encouraging prospects that the semiconductor rectifier will be developed in the near future to a point where its use on railroad motive power will be practical, encourage electric traction engineers to consider a combination of the two systems, resulting in a commercial-frequency system employing rectifier motive power with low-voltage d-c traction motors.

Commercial-frequency (or industrial-frequency) electrification has been in the minds of electric-traction engineers for many years. As noted previously, the Rochester–Mount Morris line of the Erie Railroad, electrified in 1907, was truly a commercial-frequency system in its era, utilizing the 25-cps 3-phase commercial power supply of the area with no special generating or converting equipment except 3-to-2 phase conversion through Scott-connected transformers for 2-directional distribution as single phase on the contact system.

From the viewpoints of efficiency and economy, the ideal commercial-frequency system would permit using, by the traction motors in motive power, energy as received from today's established standard commercial power-supply systems as 3-phase 60-cycle power, without change of voltage, phases, frequency, or form. This practice would eliminate intermediate transformation—and conversion—equipment costs and losses.

Voltage transformation between the point of power supply and the traction motor terminals is desirable to insure good control and equipment characteristics and for personnel safety reasons. It is relatively easily and efficiently accomplished by the use of suitable transformers at substations and on the motive power.

While 3-phase contact systems can be and have been devised, they are considered obsolete because of the mechanical and electrical complications attendant to the operation and maintenance of a double-contact overhead conductor system. Thus, any standard a-c system, including the commercial-frequency variety, must perforce operate as a single-phase system as a practical matter.

Phase conversion from three to two, to facilitate distribution to the contact system and to provide some degree of balancing of the prime power-supply system, can be readily accomplished through Scott-connected step-down transformers between the high-tension power supply and the contact system, with little increase in costs over those involved with the use of normally designed single-phase step-down transformers.

The availability of relatively lightweight a-c/d-c conversion equipment (i.e., the static rectifier) removes the necessity of considering distribution-system frequency from the standpoint of traction motor performance. Hence, there is no valid reason for considering any frequency in the distribution system other than the standard commercial frequency of 60 cps, and no necessity for changing the frequency other than to reduce it to zero in the process of a-c to d-c conversion on the motive power, where rectifier motive power is employed.

Even though direct-motored rolling stock may be employed, no change in frequency is required, providing successful 60-cps a-c motors are available. Some of the European manufacturers have developed and built 50-cycle series-wound single-phase motors for railroad work, and while these are claimed to be successful, the degree of success is questionable particularly in comparison with that obtainable with the d-c series-wound motor. American manufacturers are inclined away from the 60-cycle series-wound single-phase traction motor, particularly since better performance and costs can be secured with the rectifier/d-c motor combination.

ADVANTAGES OF COMMERCIAL FREQUENCY

THE PRINCIPAL VIRTUE of the commercial-frequency system is its ability to utilize commercially-generated 3-phase 60-cycle energy, without the intermediary of costly energy-consuming conversion equipment before the traction energy is fed to the motive power. Concomitant to this are the advantages associated in many cases with a relatively high-tension distribution system, which permits of employing a low-cost contact-distribution system.

THE QUESTION OF UNBALANCE

HOWEVER, in some cases, a penalty may be exacted for the privilege of eliminating conversion equipment in that problems of prime power-supply unbalance may be introduced, the resolution of which could offset the advantageous elimination of conversion equipment. The phase-unbalance problem has been discussed recently[1] and will not be repeated in detail here.

Where commercial-frequency electrifications are in use today, the necessity of special balancing provisions, other than those procurable with contact-system segregation between power-system phases, has not appeared. There is no guarantee that such will be the case in all applications of the commercial-frequency system to American railroading. Traffic patterns, train sizes, types of service, charac-

Table II. System Voltages for D-C Systems

A. Other Countries

Voltage	Where Used
3,300	Russia
3,000	Russia, Brazil, Chile, South Africa, Spain, Germany, Belgium, Mexico, Poland, Morocco, Algeria, Italy
2,400	Canada, Chile
1,650	Spain
1,600	Venezuela
1,500	Australia, Brazil, Chile, Czechoslovakia, France, India, Japan, Java, Netherlands, New Zealand, Spain, South Africa, Russia, England, Portugal
1,200	Manchuria, Cuba, Japan, Spain, England
1,000	Germany
840	Switzerland
800	Italy, Germany
750	Switzerland, Italy
660	Chile
650	Cuba, France, Italy, Japan, England
630	England
600	France, Mexico, England
575	Bolivia

B. United States (Main-Line Railroads Only)

3,000	Chicago, Milwaukee, St. Paul & Pacific Railroad (locomotives)
	Delaware, Lackawanna & Western Railroad (multiunit cars)
2,400	Butte, Anaconda & Pacific Railroad (locomotives)
1,500	Illinois Central Railroad (multiunit cars)
	Chicago, South Shore & South Bend Railroad (locomotives and multiunit cars)
650	New York Central Railroad (locomotives and multiunit cars)
	Long Island Rail Road (multiunit cars)

ter and capacity of the power-supply system are some of the factors that will determine whether or not special unbalance-corrective measures are to be taken in specific cases.

COMMERCIAL-FREQUENCY SYSTEM AS A STANDARD

THE COMMERCIAL-FREQUENCY SYSTEM of railroad electrification appears to have sufficient advantages over other systems to justify its recommendation as a national standard for the American railroads. Among serious students of the problem there has never been so close an approach to agreement on one system as there appears to be today, and while there are still reservations in the minds of some to the effect that there is no single system that is best for all situations, there appears to be fairly general agreement that the commercial-frequency system could well be recommended as a mainline, heavy-traction railroad electrification standard for the United States.

Under the American system of privately owned and operated railroads, recommendation of any standard practice by even such a body as the Association of American Railroads does not imply compulsion of adoption by its members, except where matters of equipment (rolling stock) interchange between railroads on a national basis are involved. Consequently, recommendation of the commercial-frequency system as a standard does not mean that if a railroad should decide to electrify, it would have to adopt the recommended standard. Nor does it imply that existing electrifications would be changed over to the recommended standard system, or if these electrifications were extended, that the recommended system would be installed. It is to be doubted that a changeover of any of the existing electrifications to the commercial-frequency system could be economically justified unless the railroad contemplated extensive new electrification compared with which the existing system would be a relatively small operation.

POSSIBLE EXCEPTIONS TO A STANDARD SYSTEM

THERE STILL EXISTS some justifiable opinion that in situations where a special railroad operation can be isolated from main-line operations involving interchange between railroads (e.g., a suburban commuter service that operates on other than main-line trackage, or that may have to be integrated with the urban transport system of the metropolitan area served by the commuter system), another than the commercial-frequency system may be the preferable and more economical method of electrifying. In such instances, the d-c systems have much to recommend them.

PROMOTING ADOPTION OF A STANDARD

FOR THE PAST SEVERAL YEARS the Electrical Section of the Engineering and Mechanical Divisions of the Association of American Railroads, assisted by representatives of some of the manufacturers and other industries who have an interest in the subject of railroad electrification, has been studying the broad subject of electrification with a view to determining whether or not standards should be recommended, and if so, what system seems most advantageous for adoption to American railroading.

There appears to be little doubt that the commercial-frequency 60-cycle single-phase a-c system is the leading candidate for the position of recommended standard for main-line, heavy electric traction. Whether or not the system can be considered as a single standard to be recommended for all new railroad electrification projects is a matter yet to be resolved.

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AEC 1957 Test Series

A series of low-yield nuclear tests will be conducted at U. S. Atomic Energy Commission's Nevada test site in the late spring of 1957. The tests should provide new knowledge important to the defense of the United States and the Free World. The development of weapons for defense against attack is a major objective. An extensive radiation monitoring network will again be used during the series. About 12 monitoring teams supplied by the United States Public Health Service will be stationed in communities near the test site.

The 1957 test series will be called "Operation Plumbob." In addition to nuclear tests, there will be further experiments at the Nevada test site similar to those announced in October 1955, related to the safety of various accidents which may occur, such as fires during handling or storage.

Half-Wave Magnetic Amplifier Circuit Input Power

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K. MURAKAMI

THE MECHANISM OF AMPLIFICATION of the self-saturating magnetic amplifier, in general, consists of its flux control of the magnetic core. In order to control the flux level in the core, the core loss must be supplied from the control circuit during the control half-cycle of the specific core. In order to demonstrate the correlation between the input power and the reset core loss in the case of the half-wave magnetic amplifier circuit, the authors introduce a mathematical model which leads to a simplified method of circuit analysis, though the actual phenomena are rather complicated. The simplified analysis assumes the reset half cycle can be closely represented by a synchronous switch in the circuit during the time the gate circuit is open. The core characteristics during the resetting interval are assumed to be those of a rectangular hysteresis loop material in which the variation of the dynamic hysteresis loop is proportional to the rate of the core flux change, i.e.,

$$i_c = i_o - k\, d\phi/dt \qquad (1)$$

for a given saturating reactor, where i_c is the instantaneous value of the control current and i_o and k are given constants. The existence of a minimum input power condition for the designated amount of reset flux is demonstrated. The optimum condition for the control circuit requires the resistance of the control circuit and the effective resistance of the magnetic core during the resetting interval to be matched. The minimum input power P_{co} is eight times the reset core loss P_r for the same amount of reset flux, i.e.,

$$P_{co} = 8\ P_r \qquad (2)$$

In the general case when the length of the resetting interval T_r is longer than a half-cycle $T/2$ the relation between P_{co} and P_r is represented theoretically by

$$P_{co} = 4\frac{T}{T_r} P_r \qquad (3)$$

To verify the validity of the simplified analysis, circuits utilizing vibratory rectifiers are employed. Reset core loss and the effective resistance of the core during the resetting interval are measured by mechanically interrupting the control circuit every gating half-cycle. The results of the simplified analysis are compared with experimental data for the half-wave magnetic amplifier under several conditions of operation. Fig. 1 compares predicted and experimental data correlating the amount of reset flux and the ratio P_{co}/P_r, for various circuit conditions. The figure clearly indicates the validity of the simplified analysis. The relation of equation 3 is checked using a half-wave magnetic amplifier circuit with a vibrating contact rectifier and d-c voltage for the gate circuit, the result of which is shown in Fig. 2. The descending portion of the dynamic hysteresis loop under the condition of measuring the reset core loss does not coincide with that of matched control circuit resistance. This is the chief reason for discrepancy between the results.

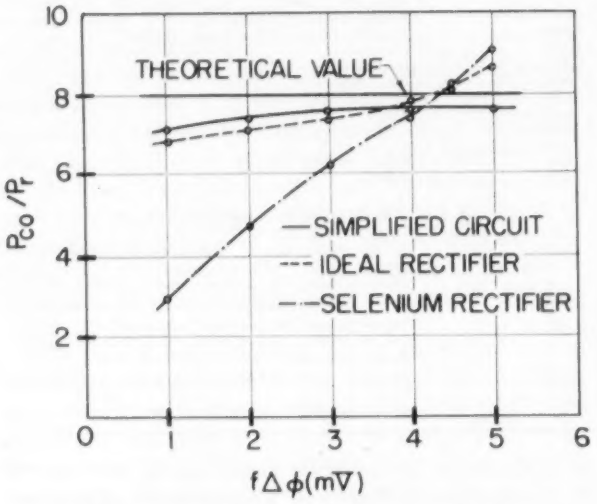

Fig. 1. Comparison of the results of several circuits.

These results should prove useful in utilizing the various types of half-wave magnetic amplifiers and also to find methods of improving their amplification.

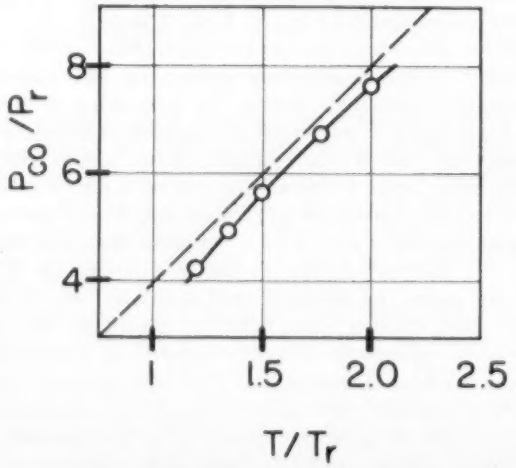

Fig. 2. Case of longer resetting interval T_r.

Digest of paper 57-5, "On the Input Power of the Half-Wave Magnetic Amplifier Circuit," recommended by the AIEE Committee on Magnetic Amplifiers and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N.Y., Jan. 21-25, 1957. Scheduled for publication in AIEE *Communication and Electronics*, 1957.

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Charging Current Interruption in SF_6

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SULFUR HEXAFLUORIDE GAS is found to have significant advantages both as a dielectric and as an interrupting medium.[1] The unique characteristics of this gas make it particularly useful in switching high voltage capacitor banks and unloaded transmission lines. Experimental knowledge of the dielectric recovery of simple arc gaps in SF_6 provides the possibility of straightforward quantitative design.

Fig. 1 shows one sample result from a study of dielectric recovery by a plain-break arc gap following extinction of a 150-rms-ampere arc. The gap had a fixed length

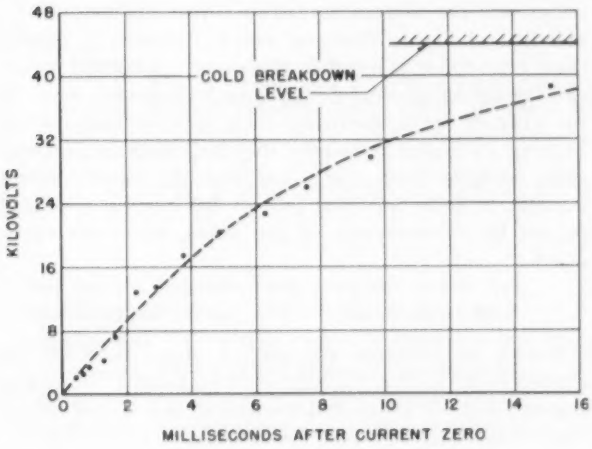

Fig. 1. Points from oscillogram showing dielectric recovery of 3/16-inch gap in SF_6 gas at two atmospheres following extinction of a 60-cycle 150-ampere arc. Dotted curve is from equation.

of 3/16 inch in SF_6 gas at 2 atmospheres absolute pressure. The gap had a cold breakdown strength of 44 kv peak. About one half of this strength was recovered 5 or 6 milliseconds after the end of the arc current. This is the critical time for occurrence or prevention of breakdown caused by a rising 60-cycle voltage across the opening contacts of a capacitor switch. The dotted curve represents an empirical equation for dielectric recovery with time over a considerable range of gap lengths and gas pressures with arc currents up to 350 amperes. Such a recovery curve can be ascribed to simple cooling of the arc path, taking no account of any remanent ionization at these longer times after current zero. Fig. 2 is oscillogram from which volt-time breakdown points in Fig. 1 were taken.

For estimating dielectric strength recovered by a rapidly lengthening switch contact gap, it is assumed conservatively that the heated arc trail is simply stretched between the contacts without being displaced. On this basis, the following semiempirical dielectric recovery equation can be written combining the effects of cooling, contact motion, and also observed effects of gap length and gas pressure on the cold breakdown strength of the gas

$$V = 83\ P^{0.7}\ (L_o + st)^{0.67}\ [1 - \exp\ (-5/7P^{0.5})]\ \text{kilovolts}$$

In this equation, P is gas pressure in absolute atmospheres, s is contact opening speed in inches per millisec-

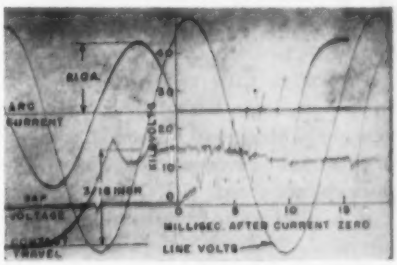

Fig. 2. Oscillogram of test.

ond and L_o is contact travel in inches before arc extinction at a current zero. This equation has been checked against actual data from tests in which restrikes were obtained. In 5 examples, observed striking voltages were from 8 per cent to 46 per cent higher than those predicted by the equation.

Compared with the time function for the restored voltage, a constant multiplied by $(1-\cos 2\pi ft)$, the critical rms voltage for which the dielectric recovery given by the foregoing equation will not be exceeded can readily be determined. For a 60-cycle capacitive circuit, this limiting value is given approximately by the simple relation $E = 3.5\ P^{0.56}\ S^{0.67}$ kv rms, where S is contact opening speed expressed in feet per second. These studies have dealt only with plain breaks in SF_6. With gas flow such as may be provided for fault interruption, the additional cooling action may increase the restrike-free voltage limit by as much as 100 per cent. Gas-filled circuit breakers demonstrating these principles have been built for moderate fault interrupting duty and switching of high voltage transmission lines.

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The "Young Engineer Blight" of the Electric Utilities

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Much has been written lately about the serious shortage of young engineers in the electric utility industry. The author points out a number of reasons why he believes the industry itself has failed to meet the problem realistically.

DURING THE PAST DECADE, electric utility engineering management has been much concerned about the relatively few young engineers seeking employment with their respective companies. Prominent engineers in this field have written many excellent articles pointing out that there are many challenging engineering problems to be solved and that the opportunities in this field of electrical engineering for achievement and position are great.

It is difficult to ascertain for whom these articles are intended. That is, can management be made to realize the seriousness of the situation through this media? Is the young engineer to be convinced that in this field is his future? Or, finally, are the articles an appeal to the engineering profession in the hope that someone will come forth with a plausible formula which can be readily applied to solve the utilities' problem?

ENGINEERING OPPORTUNITIES UNLIMITED

NEVER BEFORE in the history of this industry has there been such great opportunity for the ambitious young engineer to demonstrate his abilities as an engineer, as an executive, or both. The promotional possibilities are fantastic today as compared to the rate at which an ambitious engineer could hope to advance in professional rank 20 years ago. The electric utilities offer starting salary and rank comparable to those of other leading industries. In scope, electric utility engineering is broad, ranging through electronics, communications, and power engineering. The field is a fertile one, the requisites of which are ability, creativeness, imagination, incentive, resourcefulness, and sound engineering judgment. What more could be desired?

Why, then, is there a shortage of young engineers entering this field? Can a logical reason be given to account for young engineers shunning this great industry? The causative factors may be so overlapped that no clear-cut explanation can be explicitly stated. This is questionable however, for the following three reasons which are not necessarily indicative of all electric utility companies.

A special article recommended by the AIEE Committee on Management.

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GROWTH AND CONSERVATISM A HANDICAP

SINCE 1940 the electric utilities have had a period of tremendous expansion of physical growth. This growth has taken precedence over other important matters simply because of the urgency of meeting the demands for more and more electric power. This urgency has caused the utilities to pay little heed to the changing attitudes of young engineers who have broken the bounds of engineering conformity of the past. The day has long since passed for the ultraconservatism which has been characteristic of the utilities and which continues to plague them even today. The effect is now being realized in the shortage of young engineers entering the utility field. If the utilities are to overcome their present handicap in bidding for young engineers, they will have to do more than eulogize their companies and the opportunities therein. In short, physical growth has not been accompanied by an awareness of the young engineer's viewpoint.

GRADUATE STUDY NOT ENCOURAGED

TODAY, an electrical engineering career need not be limited to the narrow confines of 20 years ago. The young engineer has a broad choice of which he is fully cognizant. This broad field of career opportunity is mainly the result of the industrial mutations which have taken place since about 1940. But, this manifold diversity of career opportunity is not the underlying cause of the shortage of capable young engineers entering the electric utility field, although it is a factor in the distribution of the total number of available young engineers.

In past years, electric utility engineering was very exacting, and engineers had very little, if any, time and incentive for other engineering endeavors than their incessant duties. As a result of this demand, very few utility engineers in past years gave any thought to graduate studies. A common complaint by some of those hardy few who obtained advanced degrees was that they received little or no recognition for their efforts and their interests in gaining personal recognition and making contributions to their chosen field. In general, the electric utility company that indicates, or has shown, any willingness in promoting graduate educational opportunities for its engineers either before or after graduation is a rarity.

In contrast with the utility industry, electronic and communication industries have placed emphasis on advanced degrees with liberal assistance given to the capable young engineer to further his education and engi-

neering prestige. Further, these industries proffer college scholarships which provide a way and a means for a young graduate engineer to obtain an advanced degree even before he enters industry. It is a foregone conclusion that these progressive companies will be held in high esteem and favor by the young engineers, and rightly so. The trend of interest of young engineers in recent years certainly supports this claim, and the electric utilities will continue to be affected by the "young-engineer blight" as long as they offer nothing more than the usual company sales platitudes and economic security—that old refrain of long, long ago.

INADEQUATE, OR NO ADVERTISING

THE OBVIOUS LACK OF ADVERTISING by the electric utilities is peculiar. Other industries effectively advertise engineering career opportunities for the young engineer. The dynamic appeal of many advertisements in such fields as guided missiles, computers, servomechanisms, automation, etc., is tremendous. The young engineer does not realize that all of these specialties play certain roles in electric utility engineering. The digital computer, the a-c network calculator, automatic economic load dispatching, telemetering, carrier relaying, radio telephone, etc., are examples. Why, then, have the electric utilities preferred to overlook, or ignore, this means of glamorizing electric utility engineering? Traditional conservatism still rides high, and there is great concern as to why the utilities cannot get their full share of the bright, young graduating engineers. Granting that the utilities desire to reap their harvest quota of engineers, they should bestir themselves in planting the seed; otherwise, they will have to be satisfied with the gleanings.

The Bell System Speakerphone

W. F. CLEMENCY F. F. ROMANOW A. F. ROSE
FELLOW AIEE

Bell System Speakerphone provides hands free telephony. Messages are received over a loudspeaker and transmitted over a microphone located a convenient distance away. Design techniques and components of the Speakerphone are described. Customer satisfaction is indicated.

AT PRESENT, two types of "Speakerphone" are available. The one shown in Fig. 1, coded the 595-type telephone set, is primarily an individual line set, whereas the other illustrated in Fig. 2, and coded the *1A* Speakerphone System, can be used for the same purpose as well as for multiline key telephone service. In the first type, the housing is similar in appearance to the 500-type telephone set,[1] but it contains in addition to the usual components a microphone, ON and OFF keys, and a loudspeaker volume control as illustrated in Fig. 3. It will be noted that the microphone is placed at the front of the set. This location is closest to the user, and he will tend to remain within arm's distance because of the need to operate the dial and the controls. It is desirable that this distance be minimized to reduce the effects of room reverberation on the transmitted speech, and to permit the use of less amplification in the transmit circuit so that more amplification is available in the receive circuit as will be explained later. The second type has the microphone, the ON and OFF keys, and the volume control in a separate small unit. This permits greater freedom in placing the microphone and if located closer to the user results in a transmission improvement. In both types, the loudspeaker is mounted in the small plastic housing shown in the upper center of Figs. 1 and 2.

The Speakerphone is easy to use. To place a call, it is only necessary to press momentarily the ON key which lights up as an indication that the set is connected to the line. Then, when dial tone is heard from the loudspeaker, the called number can be dialed in the ordinary manner. When answering a call, the ON button is momentarily pressed, again causing it to light up, and the conversation can start. The volume of the incoming speech is adjusted by turning the small knob of the volume control. At the end of a call, the OFF button is pressed to disconnect the set from the lines. If, during a call, it is desired to use the handset, the user need only to lift it and the call is automatically transfered from the Speakerphone. If the handset is being used, and it is desired to transfer to the Speakerphone, the ON button is depressed while the handset is placed on the telephone set mounting.

COMPONENTS

AN INTERIOR VIEW of the telephone set is shown in Fig. 4. The microphone and an associated equalizer, the controls, and a set of terminals are mounted on a common bracket which is fastened to the base. The dial of

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Fig. 1. 595-type Speakerphone.

the set is equipped with two sets of contacts which close when dialing, one set prevents dial clicks in the handset while the other prevents such clicks in the loudspeaker.

In addition to the units placed on the desk, there is an apparatus box shown in Fig. 5 which contains the receive and transmit amplifiers, power supply, hybrid coil, and a relay used for the switching functions. An interior view is shown in Fig. 6. The apparatus box is connected with the other components by a suitable length of cabling so that it can be mounted in an inconspicuous location. The power is obtained from a 120-volt 60-cycle source; and the consumption is 0.6 watts in the standby and 8.0 watts in the usage condition. All amplifier components except power supply and transformers are mounted on a printed circuit card which plugs into a connector on the apparatus box in order to facilitate maintenance. The printed circuit amplifiers, one for the transmitter and one for the loudspeaker, are identical in design and use filamentary type tubes which warm to operating temperature in about 0.2 seconds. A potentiometer to regulate gain is a part of each amplifier unit and is preset at the factory.

DESIGN FEATURES

The basic circuit of the Speakerphone is shown in Fig. 7. The hybrid coil, which is a form of Wheatstone bridge, couples the two-way telephone line to the output of the one-way transmitting amplifier and to the input of the one-way receiving amplifier, and introduces a loss, L_H, between them. As indicated in Fig. 7, the unavoidable acoustic coupling, L_A, through the air path between the loudspeaker and the transmitter completes a feedback loop. When there is a net power gain at any frequency in the transmission range in this closed loop, it acts as an oscillator and singing will occur. An upper limit is therefore placed on the sum of the gain of the transmitting amplifier G_T, and the gain of the receiving amplifier G_R. Expressing the gains and losses in decibels, singing does not occur when the following condition is satisfied: $|G_T| + |G_R| + |L_H| + |L_A| \leqq 0$. Since the acoustic loss L_A is a highly variable factor and is dependent on the individual reflections from the surfaces of the room and ambient objects no control of its phase is possible. Hence, the magnitude of the quantities are chosen for the foregoing expression.

The hybrid coil loss L_H is determined by the degree of impedance balance between the telephone and the balancing network. If a perfect balance could be obtained at all frequencies, this loss would be infinite, and singing could not occur. However, the impedance of telephone lines varies considerably with frequency in magnitude and phase. It may be resistive, capacitive, or inductive,

Fig. 3. 595-type Speakerphone housing.

depending on the length and make-up of the loop to the central office, and on the length and type of trunk between central offices. The variability of impedances is especially true for PBX installations, where internal calls may be on a short loop, and external calls may be on a long loop. There is, fortunately, a rough correlation between loop impedance and loop direct current, and advantage is taken of this fact in the design of the balancing network. The operation is similar to that of the variable antiside tone network of the 500-type telephone set.[2] The action is as follows: the direct current path through the Speakerphone circuit is from one side of the telephone line through a winding of the hybrid coil to the inductance coil L and thence to the other side of the telephone line. It is the voltage drop across the inductance coil, which has an 85 ohms resistance, that serves to regulate the impedance of the variable network. The variable component is a symmetrical silicon carbide

Fig. 2. Speakerphone system No. 1A.

varistor, the resistance of which is high for low direct voltages and low for high direct voltages. Fig. 8 indicates the relationship between the loop direct current and the impedance of the balancing network. Fig. 9 shows the increase that this network offers in the permitted receiving gain before singing occurs in comparison with a nonreactive 1,000 ohm resistance. The plotted points above the dashed line represent increases and the points below the line represent decreases. These data were obtained on 30 telephone connections representing a range of battery, trunk, and loop conditions most likely to be encountered in service. It will be noted that the reductions occur on some short loop connections where the amount of receiving gain required is small and singing is not a limiting factor. On the average, the variable network shows a five db better balance than a fixed 1,000 ohm resistance.

The incoming signal from the telephone line is supplied to the receiving amplifier through the hybrid coil, a two microfarad blocking condenser, and a volume control which consists of two potentiometers with a common shaft arranged in a balanced circuit to minimize crosstalk and electrical noise pick-up. A fixed resistor, between the potentiometers, assures that the gain cannot be reduced below a minimum sufficient to enable the loudspeaker to produce dial tone at an easily heard level. In addition, most local calls may be received with the volume control at this minimum position.

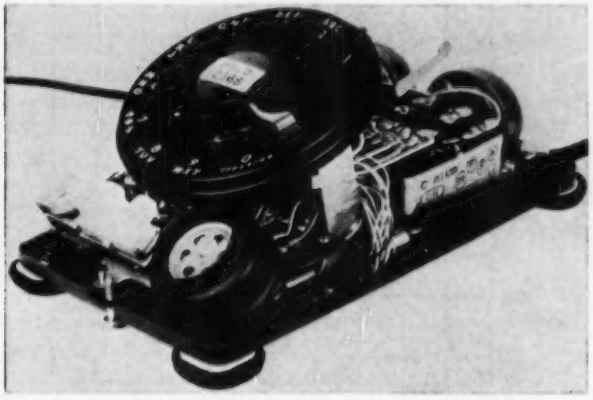

Fig. 4. 595-type Speakerphone interior.

LIMITING ACTION OF THERMISTOR

An especially designed thermistor-resistance combination is shunted across the output of the receiving amplifier, as shown in Fig. 7. By limiting the steady-state output voltage of the amplifier, the thermistor assures that the singing tone, when it occurs, cannot exceed 70 db sound level at the normal listening distance (See American Standard, Acoustical Terminology, Z24.1–1951). Thus, a disturbing howl is reduced to a soft audible tone. The limiting action of the thermistor also takes place in the case of speech. Because of the fluctuations in this type of signal and the integrating properties of the thermistor, speech pressures may reach an 80 db sound level. This sound pressure is approximately 10 db above the level of conversational speech at one meter and is sufficient to provide satisfactory reception for noise levels below 60 db. The volume limiting action of the thermistor is also valuable in reducing talker echo at a connected telephone. This effect results when the received loudspeaker signal is high and occurs primarily on local connections.

Fig. 5. Components of Speakerphone system No. 1A.

The amplifiers have two stages of conventional Class A design employing input and output transformers with *RC* interstage coupling. The transmitting amplifier is adjusted at the factory to have an "ideal transducer" gain of 51 db at 1,000 cycles per second. For a person speaking at 18 inches from the microphone this setting produces a line level which is approximately equal to that obtained from a 302-type telephone with the same person one inch away from the handset transmitter. A decreasing high frequency response is provided in order to help equalize the microphone characteristic. The receiving amplifier is adjusted to a 44 db gain, which can be reduced 33 db by the manual volume control. A decreasing high frequency response serves to balance the rising characteristic of the loudspeaker.

ACOUSTICAL CONSIDERATIONS

The microphone in this set is a modified *U1* receiver unit,[3] enclosed in a small case to give it a definite acoustic

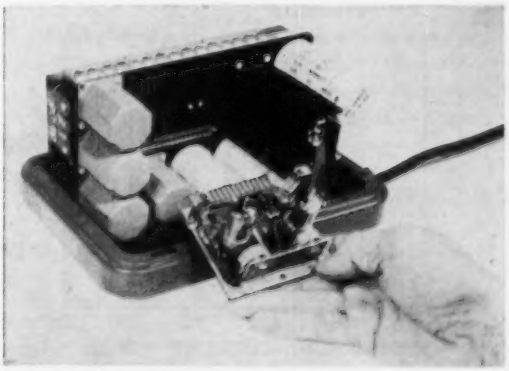

Fig. 6. Apparatus box and printed circuit amplifiers.

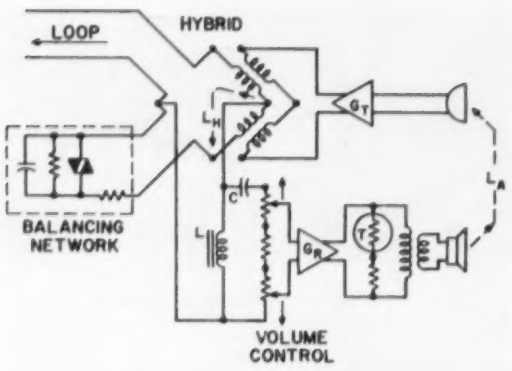

Fig. 7. Basic circuit of Speakerphone.

chamber volume. To minimize irregularities in the transmit response resulting from reflections of sound by the desk surface on which the Speakerphone rests, the microphone is mounted in front of the set and as close to this surface as possible. The microphone mounted in this way gives a response which rises in the high frequency range. To compensate for this, an equalizer is connected across the unit and the resulting response, including the change introduced by the amplifier characteristic, is shown in Fig. 10. By experiment, this response has been found to be a good compromise for speech quality, for the reduction of the effects of room reverberation, for the reduction of echo, and for the control of the singing characteristics of the set. Basically, the microphone is a nondirectional pressure unit, but because of the size of the telephone set, it has some directivity at frequencies above 1,000 cycles. However, this directivity is small enough so that the total variation in transmit level for speech originating equidistant from the microphone is only about 5 db for all directions around the set.

The receive response of the Speakerphone as shown in Fig. 10 decreases at the higher frequencies. This produces a more pleasant quality for speech received from a connected handset telephone over local lines without a serious degradation of articulation on long lines. Because the higher frequencies are augmented by the sound diffraction effects of the listener's head,[4] the sound pressure at the entrance of the ear canal actually rises at frequencies between 1,500 and 3,000 cycles per second as indicated in Fig. 11. These reflections do not occur with the regular telephone receiver held close to the ear. The loudspeaker is also nondirectional at the lower frequencies and slightly directional because of its size at the higher frequencies. A small loudspeaker was selected to minimize the size of the desk top components and to provide flexibility in placement.

It has been found that better control of the singing properties of the set is obtained when the transmit frequency response is approximately complementary to the receive response. In this case, the singing loop has a relatively flat frequency characteristic which permits maximum effective transmit and receive gain. However, a set having this characteristic is likely to sing at any frequency. In order to prevent singing at frequencies above 1,000 cycles, easily produced by bringing the hand or any small object near the microphone, it is better to tailor the loop characteristic to sing at low frequencies.

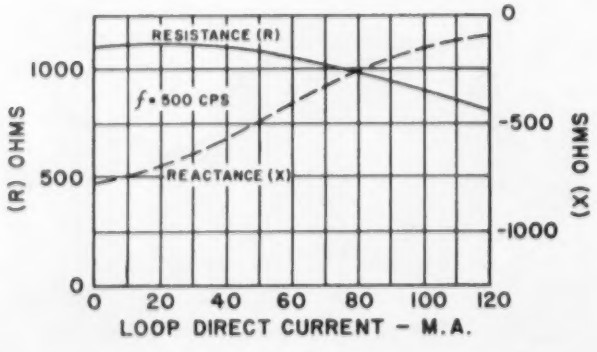

Fig. 8. Impedance of balancing network for different loop direct current.

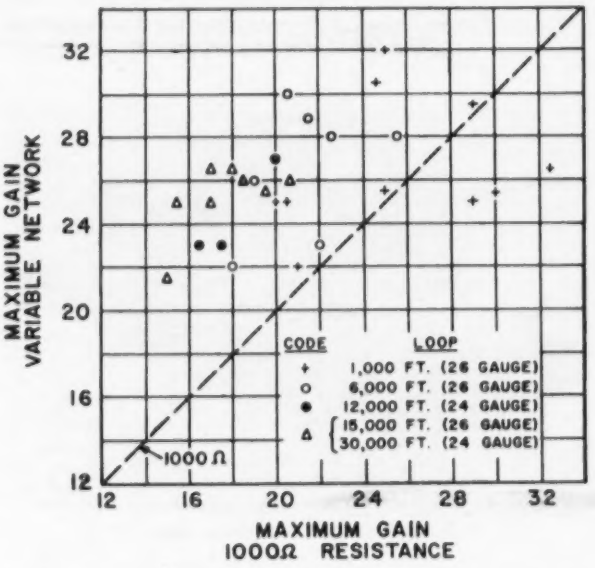

Fig. 9. Maximum gain-variable network compared with 1,000 ohm resistance.

ANALYSIS OF SINGING LOOP

A METHOD OF STUDYING the singing loop is outlined in Fig. 12. In this method, the loudspeaker is disconnected from the set and a 10-ohm resistance which is equal to the nominal impedance of the speaker is connected in its place. An oscillator maintains a constant voltage E_1 across the loudspeaker. The voltage E_2 returned to the 10-ohm resistance is measured. The set is arranged on a table top in the recommended operating position. The voltage E_1 applied to the loudspeaker is 0.1 volts, which is within the range applied to the loudspeaker during normal operation of the set. The ratio of E_2 to E_1 is a transmission

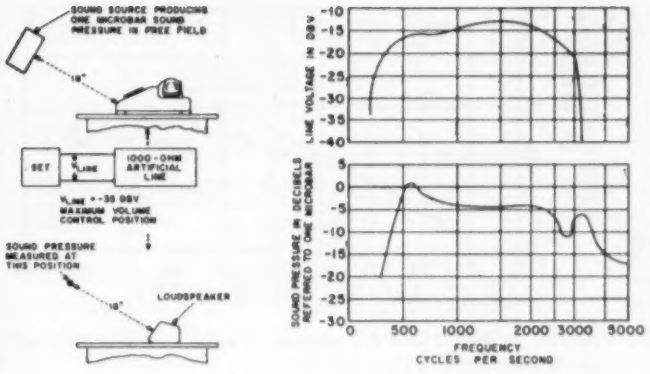

Fig. 10. Frequency response—transmit and receive.

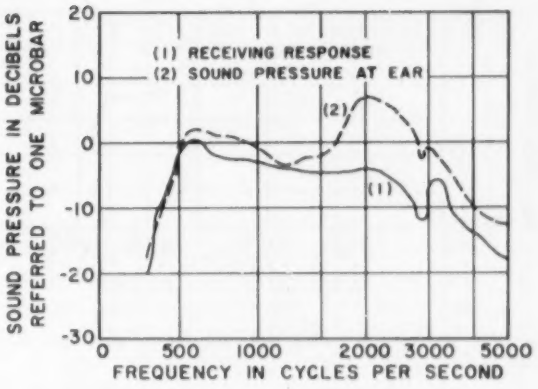
(1) RECEIVING RESPONSE
(2) SOUND PRESSURE AT EAR
SOUND PRESSURE IN DECIBELS REFERRED TO ONE MICROBAR
FREQUENCY IN CYCLES PER SECOND

Fig. 11. Receive response—effect of head diffraction.

measurement of the singing loop and is called the return voltage ratio. The set will sing when this voltage ratio is greater than one. Adjustment of the volume control to a lower gain position reduces this ratio and singing will cease when the ratio becomes less than one. To obtain reproducible conditions, the variable balancing network is replaced with a 1,000-ohm resistor and the line terminals of the set are connected to 800 ohms. This produces an unbalance in the hybrid coil of a definite, easily reproduced amount. A measurement of this return ratio is shown in Fig. 13. These data indicate that the return ratio has a fairly flat frequency characteristic with no sharp peaks and that singing would occur at a low frequency, about 600 cycles per second, which is desirable as pointed out previously.

The other factor influencing singing is the acoustic coupling between the microphone and the loudspeaker. With nondirectional transducers, this coupling is controlled by the distance between the instruments, becoming less as the distance is increased. The variation in permissible gain as the distance between microphone and loudspeaker is changed is shown in Fig. 14. An increase in this distance allows more gain to be used in the loudspeaker circuit. However, beyond a certain separation, further increase in the distance between the instruments moves the loudspeaker farther from the user and hence causes a decrease in signal at his ears for the same loudspeaker circuit gain. The optimum practical arrangement is to have the user approximately midway between the instruments which are separated by about three feet on the desk top. Fig. 14 also indicates that the acoustic properties of the room influence the permissible gain which may be used in the loudspeaker circuit. In a reverberant room having little sound absorption, the permissible gain before singing occurs is less than that in a room with good sound absorption.

In experimental sets of this type, reduction of acoustic coupling between the loudspeaker and the transmitter was attempted by using various types of directional instruments for the microphone and also for the loudspeaker. It was found that low coupling could be obtained in a free-field room with some combination of directional instruments. However, this coupling increased considerably in a room having the acoustic properties of normal offices. Also, this coupling was influenced considerably by the position of ambient objects and persons in the vicinity of the loudspeaker and the microphone. The reduction in the acoustic coupling obtained by increasing the distance between the microphone and the loudspeaker seems to be less adversely influenced by room acoustics and ambient objects than the reduction obtained through transducer directivity. The use of nondirectional transducers also permits greater flexibility in design of housings and the placement of the transducers.

APPLICATION IN THE BELL SYSTEM

Up to the present time about 75,000 Speakerphones have been put into service by the Bell System companies throughout the United States. They are used in a great variety of situations but more extensively in business offices than in residences. Moreover, there is a wide diversity in the type of organizations that have found them of value.

Because the Speakerphone is subject to transmission limitations and is now being used in sufficient numbers to have a possible over-all impact on customer reaction to telephone service in general, a survey was made at the consumer level. This was done to determine the degree of satisfaction experienced by users of the Speakerphone, and to find out whether they felt that it was worth its cost to them. Interviews were conducted on the premises of some 500 customers and comparable questions were

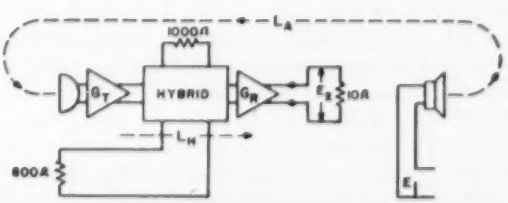

Fig. 12. Circuit for singing loop study.

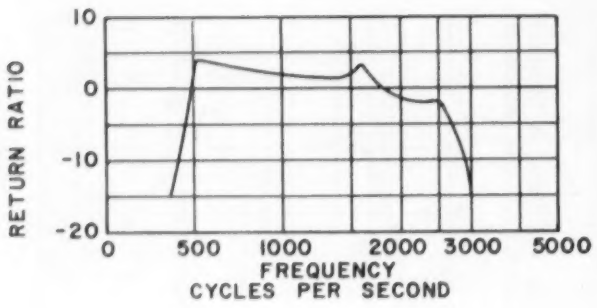

Fig. 13. Singing loop return ratio showing a fairly flat frequency characteristic.

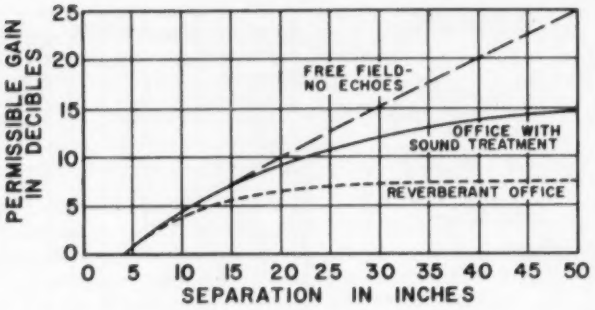

Fig. 14. Permissible gain for increasing distance between microphone and loudspeaker.

asked of all. This sampling covered all types of customers. There were included heavy and light industries, welfare organizations, financial institutions, Government agencies, utilities, etc.

It does not seem necessary to include here all of the details of the questions and the extensive analysis made of the answers. It is sufficient to say that 85 per cent of the users interviewed felt that the service was worth what it cost. About 90 per cent were "fairly" or "entirely" satisfied with the service. One particular item of interest was that the physically handicapped had found it extremely helpful and in some cases were able to continue useful employment when otherwise they would have been unable to do so. Most of the customers were aware that the equipment had some limitations and exercised a reasonable amount of discretion in keeping their usage within its capabilities. This is made evident by the fact that 25 per cent of the customers indicated that they occasionally transferred to the regular handset for transmission reasons rather than try to use the Speakerphone when conditions appeared too adverse.

In analyzing the transmission difficulties that were encountered, most of the unfavorable reactions were from the subscriber at the distant end of the connection. Frequently he noted a "barrel effect" and commented unfavorably on this to the user of the Speakerphone. The Speakerphone customer himself occasionally had trouble with inadequate volume on connections involving a low volume talker at the distant end of the circuit, or on some switched conections which may have had more than average transmission loss. In some of these cases, he may have attempted to correct the situation by turning his volume control too high and thus produced howling which was noted by the party at the distant end.

The primary purpose of the Speakerphone is to leave the hands free during telephone conversations. In addition to this primary purpose, however, several of the customers noted other advantages. For example, when waiting for the distant party to answer they avoid the necessity for holding the receiver to their ear, and a few mentioned the additional comfort and avoidance of fatigue in the case of calls lasting for an extended period. There were a number of favorable comments on group usage particularly when small groups were involved, and some customers' stenographers found it useful for taking notes without any other special equipment.

In conclusion, it may be said that the present type of Speakerphone fills a real need and its use will undoubtedly continue to expand. If some of the above-mentioned technical difficulties can be overcome an even larger field of application would appear to be indicated.

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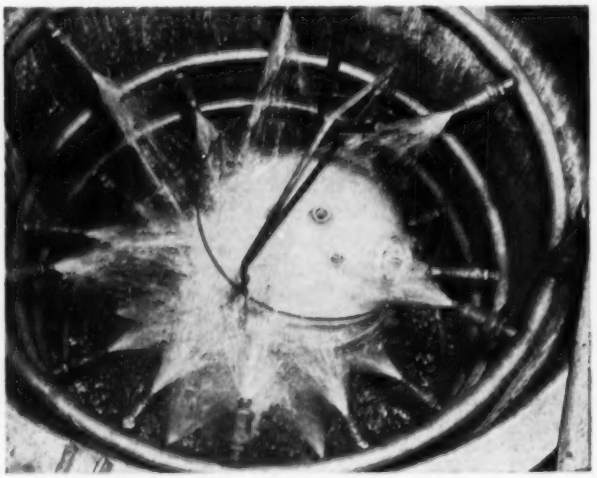
Shower Bath for Vanguard Tanks



One of the Glenn L. Martin Company's high-pressure tanks for the earth satellite is heat treated to 970 degrees and then given a quick cold quench. The usual tub was out of the question so this shower bath was devised. Shower consists of many nozzles attached to a circular pipe around inside wall of a regular tub.

Emissivity Effects on Stranded Aluminum Conductors

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H. E. HOUSE
MEMBER AIEE

AN APPARATUS for the measurement of total hemispherical emissivity of stranded conductor was recently developed. A measurement is made by suspending the specimen in the center of an evacuated chamber, heating the specimen, and taking a cooling curve. New stranded aluminum conductors have emissivity values of about 20 to 25% (per cent); old, weathered conductors may have emissivities of 90% or higher. Data tending to confirm the values of emissivity obtained are presented in the form of actual temperature rises of several sizes of stranded conductor under controlled conditions. It is shown that the values of convected heat loss obtained by subtracting calculated radiated heat loss from the measured I^2r input to the conductor check very closely for both new and blackened conductors.

The temperature rise, upon the passage of electric current, of transmission conductor is important to electric power utilities. To set limits for peak loading or emergency operating conditions, the value of current is needed which will cause the maximum allowable operating conductor temperature.

In the past, formulas have been used with an emissivity factor of 4 to 6% for aluminum conductor, based on measured values for flat plates. The values obtained by the method described in this paper indicate that emissivity values for new conductor vary between 20 and 25%; conductor blackened by service may be as high as 91%. Part of the surface between strands causes multiple reflections which approach the effect of a black body.

The values of emissivity for both new and blackened conductors have been checked very closely against recent temperature-rise test data for a wide range of conductor sizes. The method used was to pass current through the new conductor until the equilibrium temperature at or near 95 C was reached. After the conductor was painted flat black, current necessary to maintain the same equilibrium temperature was again passed through the conductor, with the ambient temperature remaining as constant as possible. All stranded conductors tested were from ordinary mill production, with normal tolerances.

The heat balance equation for an overhead electrical conductor during equilibrium conditions is

I^2r + absorbed Solar heat = Radiated heat + Convected heat

Inasmuch as the tests were performed indoors, the effect of solar heat disappears; rearranged, the equation becomes

Convected heat = I^2r — Radiated heat, or $q_c = I^2r - q_r$

The heat removed by convection should be approximately the same for both new and black conductor under equal temperature differentials and air velocities caused by natural convection.

The results of these indoor laboratory tests on 120-foot spans of conductor under tension are shown in Table I, together with the calculated values of q_r and q_c. Emissivity factor for new conductor was taken as 0.231, which is the average of four samples, and for blackened conductor as 0.91. In the expression for radiated heat, values of temperature and conductor outside diameter are accurately measured quantities. The power input to the conductor was accurately measured.

In each conductor tested, the values for convected heat from both the new and black conductor check within the limits of experimental error. This could only be true if correct values of emissivity were used in the computation of radiated heat loss. Values of emissivity which would be obtained from flat plate tests would cause considerable error.

Table I. Test Results of New and Blackened Stranded Aluminum Conductors

Conductor Physical Characteristics	Ambient* Temperature, C t_a	Conductor* Temperature, C t_c	Effective Resistance* at t_c, Ohms/Mile	60-cps Current*, Amperes I	Watts per Foot I^2r	q_r	q_c
New no. 4 ACSR 6/1 0.250-inch diameter	24	86	2.795	100	5.23	0.52	4.71
Same except painted black	28	91	2.815	120	7.68	2.94	4.74
New 4/0 ACSR 6/1 0.563-inch diameter	23	93	0.640	309	10.9	1.8	9.1
Same except painted black	21	93	0.640	370	16.6	7.4	9.2
New 795-mcm ACSR 30/19 1.140-inch diameter	30	95	0.1505	810	18.7	3.6	15.1
Same except painted black	32	95	0.1505	1010	29.1	13.9	15.2
New 1.75-inch diameter expanded ACSR	26	93	0.0846	1280	26.2	5.6	20.6
Same except painted black	23	93	0.0846	1650	43.7	22.6	21.1

*Measured values.

Symbols: P_r = electrical power input supplied to conductor in watts per foot
q_r = radiated heat loss from conductor in watts per foot
q_c = convected heat loss from conductor in watts per foot
$q_c = I^2r - q_r$ for equilibrium thermal conditions

$$q_r = 0.138\, De \left[\left(\frac{K_c}{100}\right)^4 - \left(\frac{K_a}{100}\right)^4\right] \text{ watts per foot of conductor}$$

where
D = conductor outside diameter, inches
e = emissivity factor
K = degrees C + 273

Digest of paper 56-722, "Emissivity and Its Effect on the Current-Carrying Capacity of Stranded Aluminum Conductors," recommended by the AIEE Committee on Transmission and Distribution and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Summer and Pacific General Meeting, San Francisco, Calif., June 25-29, 1956. Published in AIEE *Power Apparatus and Systems*, October 1956, pp. 970-76.

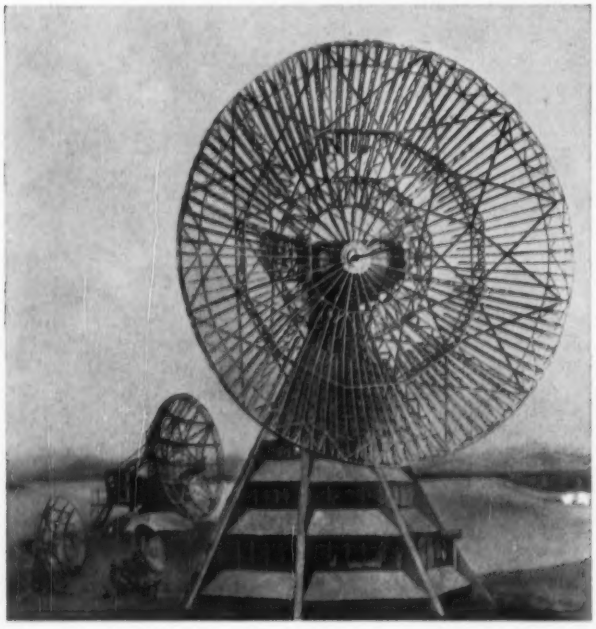
C. S. Taylor is with the Aluminum Company of America, New Kensington, Pa.; H. E. House is with the Aluminum Company of America, Massena, N. Y.

German Radio Observatory Stockert

T. PEDERZANI

During the past 20 years the world has been aware of electromagnetic radiation from the universe. Numerous institutes exist in a number of countries for exploration of this radiation. The Federal Republic of Germany has now set up a radio telescope with an antenna diameter of 25 meters for research on the 21-cm radiation of interstellar hydrogen. Precision of reflector construction and servo technique are unusual.

RADIO ASTRONOMY, the exploration of universe-emitted electromagnetic radiation at wave lengths in the centimeter and meter ranges, was started after World War II, especially in England and Australia. In these countries, radio telescopes have been developed which are equipped with antennas of rather large dimensions in order to provide the necessary resolution. Some have been designed as group radiators, others as parabolic reflectors. Some are of the fixed type, and the radio star must pass to be observed; others are movable antennas, which permit aiming at the same point of the sky despite the rotation of the earth. The Federal Republic of Germany has erected a radio telescope for the observatory of Bonn University on Stockert Mountain near Muenstereifel (approximately 24 miles southeast of Bonn), at a cost of $700,000. This telescope is the first of its kind in West Germany and can receive 21-cm radiation (1,420 mc) emitted by the interstellar hydrogen from the Milky Way.



Courtesy Telefunken

Fig. 1. The three German radar sets "Wurzburg," "Ansbach," and "Riese," are compared with the radio telescope.

EQUIPMENT DESIGN AND MEASURING POSSIBILITIES

IN THEIR DESIGN, radio telescope antennas are similar to the antennas of the radar equipments that were used for detecting and tracking flying targets during World War II. Fig. 1 shows the three West German equipment types "Würzburg," "Ansbach," and "Riese," as well as the new radio telescope. The corresponding antenna diameters are 10, 15, 25, and 83 feet. Whereas a radar antenna emits energy and receives a small fraction of that energy again through the same antenna (the portion reflected by the target), the radio telescope acts exclusively as a receiving device. The reflector must have a large diameter in order to obtain a sufficient degree of resolution.

The diameter is about 120 wave lengths, thus yielding a width of the directivity pattern of about 0.7 degrees. The antenna can be rotated in azimuth and elevation, and a servomechanism controlled by a mechanical analog computer ensures that the reflector will move in a manner that makes the antenna always look at the same point in the universe. During the observation action, the frequency of the receiver can be varied continuously by an automatic switching device so that radiation intensity versus wave length may be plotted by a recorder. The receiver thus represents a spectrometer. The antenna can also be moved independently of the aforementioned analog computer by manual control, and further provisions have been made for automatically tracking a flying target since there are plans for radar research activities.[1]

RECEIVER

THE INTENSITY of the radiation to be received is extremely small. It is about 13 db below the noise of a resistor at room temperature. Because a well-functioning 1,420-mc receiver has an inherent noise figure of about 8.5, the task is to receive energy which is 21.5 db below the inherent noise. Hence, the useful signal is smaller than 1 per cent of the interfering signal. This task has been solved by switching the receiver between a fixed frequency f_1 and a variable frequency f_2 and amplifying the

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difference between the receiving energies. Fig. 2 shows an oversimplified block diagram of the receiver for better understanding. By electronic switching from oscillator *Ia* to *Ib* (500 times per second), the receiver is ready to receive alternately f_1 and f_2. Although the receiver input must have a sufficiently large bandwidth because of this switching action, the first intermediate frequency (52 mc) has only one of 1.4 mc. Further toward the output, the bandwidth becomes progressively smaller, e.g., it is only 30 kc in the third i-f stage. After demodulation, the 500-cycle switching frequency is fed through a selective amplifier to a phase detector where it is detected to the proper phasing by a 500-cycle switching pulse before being fed into the recorder via an integration device at a time constant of about 100 seconds. In the recorder, the frequency spectrum is registered. Noise elimination is attainable to a degree in this receiving technique.[2] The measurement of each spectral line takes a few minutes; oscillator *Ib* is then adjusted to another frequency by an automatic device, etc. By means of a prepared perforated tape, the desired frequencies may be adjusted to a certain schedule at intervals of at least 4 kc and not more than 150 kc. It is thus possible to cover a frequency range of special interest at narrow intervals and another range at wider intervals. The receiver is shown on Fig. 3. Its r-f section has been placed in a special cabin right behind the reflector.

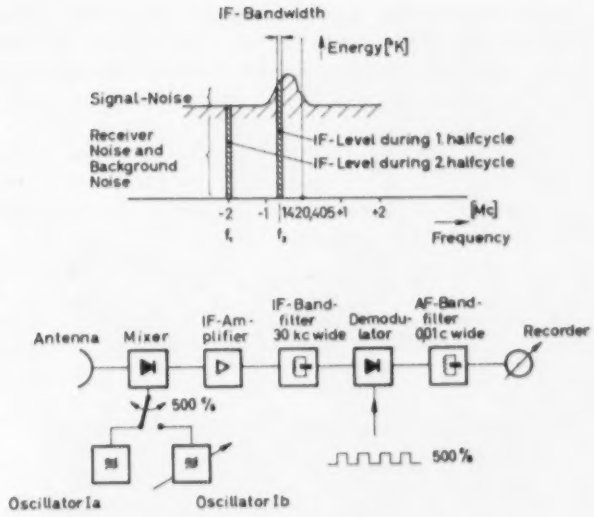


Fig. 2. Receiving technique and simplified block diagram for receiver of radio observatory.

REFLECTOR, BEARINGS, AND DRIVE

A SECTIONAL VIEW of the entire system is shown in Fig. 8. The reflector consists of a light metal alloy, all parts of which are eloxadized against corrosion. The inner supporting ring is made of steel. During the reflector's construction, a maximum deviation from the paraboloid shape of ± 5 mm was noticed. The reflector is covered with perforated sheet metal, the holes being 10 by 10 mm in size and the connecting straps about 2 mm wide. This sheet metal looks like a wire mesh but its electrical effect is almost that of solid sheet metal. The perforations prevent too strong a concentration of heat in the focus resulting from sun radiation. This effect already is lessened by the eloxadized rough surface, and it also reduces the wind load by about 20 per cent, as ascertained by wind-tunnel measurements.

For the time being, the reflector will be used for reception of the 21-cm radiation arriving from the universe. Provisions have been made, however, to include the reception of other wave lengths. Because of its small deviation from the nominal paraboloid shape, the reflector can even be used for wave lengths of a few centimeters. This will actually be done in the future. The lower limit is set by the size of the perforations that permit waves of the shortest centimeter to pass. Naturally, longer waves can be received without any difficulty. Undoubtedly, this will require exchange of the receiving dipole for which provisions have been made.

The reflector rests on a tubular turning axis, suspended in a large ball bearing (external diameter about 9 feet) and having a bearing at its foot which can be moved in a cross-slide. In this manner, it is possible to obtain accurate vertical adjustment of the rotating axis. Rotation in azimuth of the reflector is accomplished by a d-c motor of approximately 8 kw via a spur wheel gear (Fig. 8), which hangs on the pivot so that it will move along with the readjusted axis. It has been secured against joining the rotation by an anchor in the concrete floor. The large drive tooth wheel has a diameter of about 10 feet, a maximum dividing error from tooth to tooth of only 3 mils, and an error between any two teeth of only 12 mils.

Winding stairs have been provided in the interior of the tubular axis which lead to a yoke containing the drive for the rotation in elevation. Provisions were made to adjust the tilt axis by optical means to a position which is exactly normal to the vertical axis when bedding the tilt axis. The feeder lines for the motor and the servo control go through 150 sliding contact rings (Fig. 5). An r-f cable (52 mc) is also conducted through the center of this set of sliding contact rings; yet it does not lead over the

Courtesy Telefunken

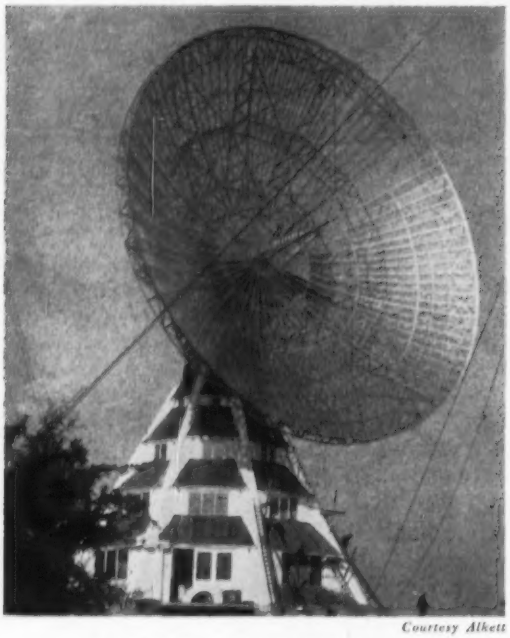
Fig. 3. Radio observatory receiver without r-f section.

sliding contacts but through a special rotary joint. The winding stairs also lead to the cabin behind the reflector from where the reflector can be entered through a removable trap door, for the purpose of exchanging the dipole.

The reflector was assembled at the installation site (Figs. 6 and 7), lifted as a whole by two cranes, and brought into the bearings. Fig. 8 shows an over-all view of the radio observatory.

SERVO CONTROL

If the reflector were embedded in a rotating axis in parallel with the earth axis, it would only be necessary

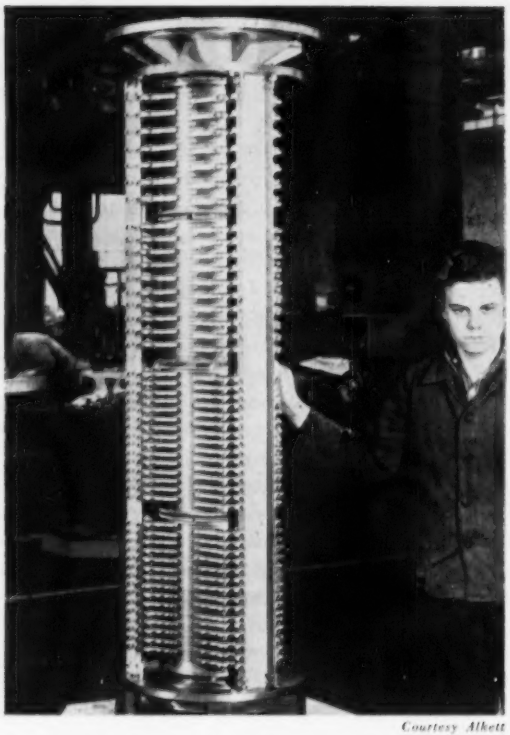


Courtesy Alkett

Fig. 4. View of radio telescope.

for radio-astronomical purposes to drive it against the earth rotation in reverse sense by 15 angular minutes per time minute. As this parallactic bearing has not been used but the rotary axis has been placed perpendicularly on the earth surface and the tilt axis situated in a right angle to this vertical line, the reflector must be moved in azimuth and elevation according to a calculable schedule. These movements are derived from a mechanically operating analog computer (co-ordinates transformer) which is driven by a synchro motor of a 50-cycle a-c voltage which is derived from a crystal. This ensures that the drive will always be exactly in time. The output values of this computer represent the nominal values for the reflector position in azimuth and elevation. The reflector can then be servoed with such accuracy that the error between electric axis and its indication remains less than 5 angular minutes.

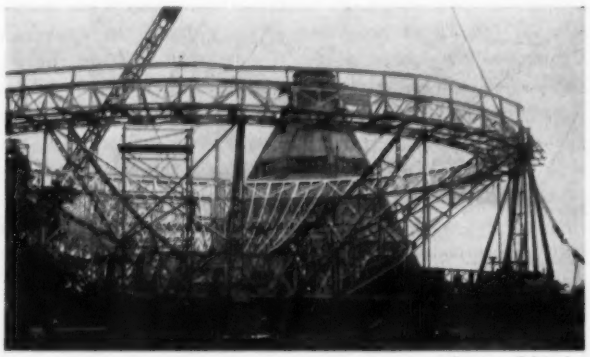
The analog computer used was developed from an instrument designed at Collins Radio Corporation by



Courtesy Alkett

Fig. 5. Set of sliding contact rings in vertical axis of antenna (150 sliding contact rings).

Hagen. The basic principle of the instrument is a model that continuously transforms the co-ordinates in three dimensions. The structural type as realized by Schierbeck of the Dutch firm of Rademakers is presented in principle in Fig. 9. By rotating the semicircular bow around the horizontal shaft B, the equipment is aligned to the declination of star S to be observed so that the latter will maintain its fixed position opposite the base of the equipment when it is operating. The angle formed by shafts A and C represents the geographical latitude of the observation site. The three-dimensional gear chain, consisting of three links and built into the equipment within the semicircular bow and the U-shaped basic structure, is



Courtesy Telefunken

Fig. 6. Assemblage of antenna at mounting site.

driven around the vertical axis in synchronism with the sidereal time. The rotating and tilting angles then can be determined at shafts *C* and *D*. The transmission of these angles to the rotating and tilting shafts of the radio telescope is accomplished by means of a servo control mechanism (Fig. 10). With the aid of selsyn systems, the actual position of the shaft to be synchronized is compared with the wanted position at the analog computer. If there is no conformity of the angular position, an a-c voltage appears whose phase indicates the deviation direction, while its amplitude reports the deviation size. This voltage is fed, after phase discrimination by means of tube amplifiers and upon rectification, to the control winding of an amplidyne machine whose armature supplies a d-c voltage which actuates the drive motor of the shaft to be synchronized. As soon as the latter approaches the wanted angle, the d-c voltage becomes progressively smaller. Upon angle coincidence, the voltage becomes zero and the drive motor stops running.

In order to achieve the required accuracy, the analog computer as well as the rotating and tilting shafts are each provided with a second selsyn system (vernier system); these systems are driven at a higher number of rotations. Indication of the actual antenna position is obtained also by means of multiple selsyn systems.

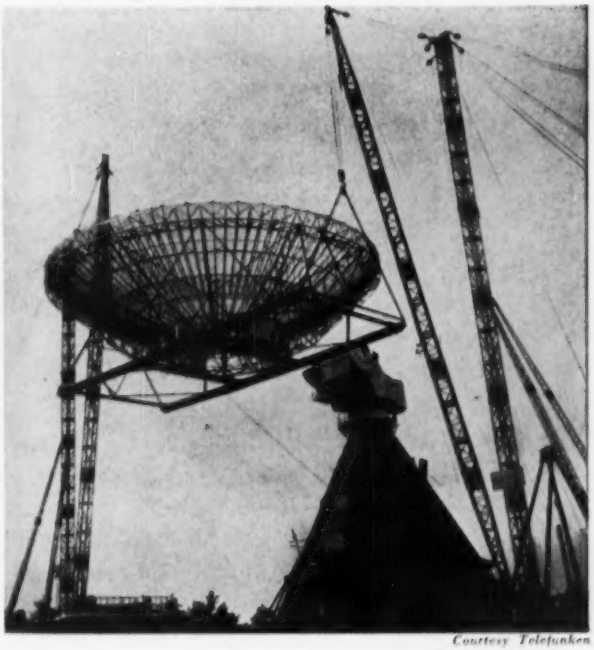
In checking equipment accuracy, the result obtained from a series of more than 150 measurements was the following:

Load on Adjusting Motor (per cent)	(Minutes) Static Angle Error		(Minutes) Error with Constant Angle Speed	
	Average	Maximum	at 0.5° per second	at 1° per second
Torque = 0	±0.2	−0.4	0.6	1.0
Torque = 100	±0.4	−0.5	0.8	1.4

For the purpose of radar research, the reflector must be rotated and tilted at much greater speed (about 1 degree per second). This requirement determines the power of the driving motors (servo motors) and, thus to a large extent, the total cost of the servo system. For the radar system also, target tracking according to the output values of the radar receiver is desirable. In each case, it will be necessary to steer the reflector into a starting position by hand so that as a whole three operating controls are required; i.e., schedule control, servo control, and manual control.

BUILDING STRUCTURE

For the building, the shape of an octagonal pyramid was selected. It serves as support to the machinery and, therefore, must stand the forces of its own weight, wind or snow loads. The choice was between a steel or steel-reinforced concrete structure. The latter was given preference for the following reasons: (a) The forces imposed upon the structure were easily withstood and, without any great efforts, there was such negligible shifting as could have been attained only when using heavy steel weights; (b) Steel concrete possesses the very desirable characteristic of poor heat conduction so that any deformation of the building due to one-sided exposure to sunlight as a result of the long time constants will not be as strong as that of a steel structure with good heat conduction.



Courtesy Telefunken

Fig. 7. Hoisting the 83-foot antenna by means of two cranes.

Along with the static calculations for the building, the

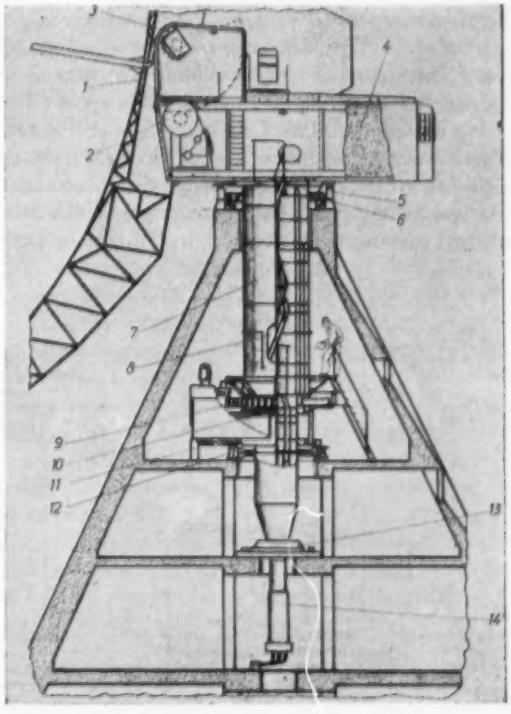


Fig. 8. Over-all view of radio observatory.

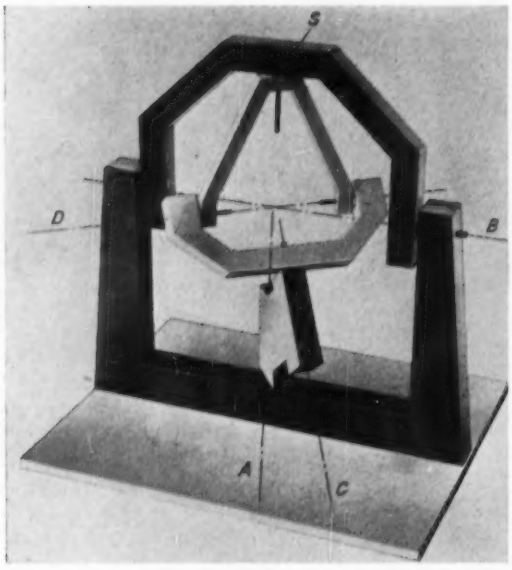


Fig. 9. Schematic model of co-ordinates transformer. A—hourly axis; B—declination axis; C—azimuth axis; D—elevation axis.

total shift of the building top as a result of wind loads was also ascertained. Under most adverse conditions, it will only be 0.6 mm, which means an angular shift of approximately 0.1 angular minute. This shift was calculated on the assumption that the building must be considered a girder which is rigidly fixed into the rocky ground and which reduces in floor space toward its top. This shift is far below the shiftings in the machinery part of the structure, those shiftings being within a whole angular minute. The building foundation is formed by bedrock. The structure weighs about 1,100 tons.

In order to keep down the heat absorption of the building, the eight pillars were provided with a coat of paint from suspension lime material having a light color. The sloping areas below the windows have been covered with a special type of roofing material which has an aluminized surface. The roofing material chosen was subjected to laboratory tests, and its heat reflection coefficient was found to be especially high.

The basement of the building houses the transformer station as well as a spare power generator set. On the first floor, there are rooms for radio astronomy, with separate rooms provided for radar measurements. The second and third floors contain the work rooms for the scientists, and the rotary angle drive is located on the fourth floor. All rooms can be heated electrically; they are equipped with so-called storage stoves which are run by inexpensive night current. They store the heat in magnesite material of a very high storage capacity; this material is embedded in nichrome wire. The amount of heat needed for the entire house at an outside temperature of —20 C was found to require 165 kw. For an electrician on permanent duty, living quarters have been provided in a separate house near the tower building. A deep well supplies the water from a depth of 400 feet.

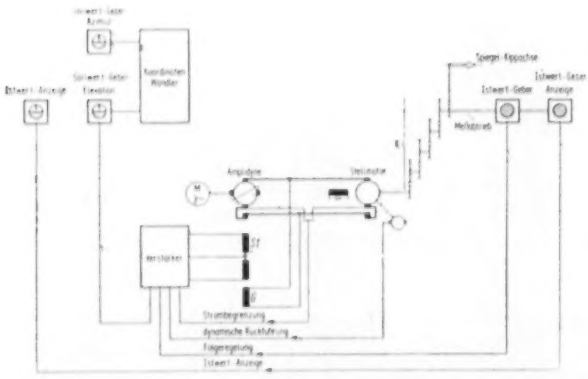


Fig. 10. Simplified functional diagram of servo-controlled reflector movement.

CONCLUSION

THIS ARTICLE describes the equipment design and the measuring devices of the West German radio telescope for astronomic research. This radio telescope is not the largest of its kind (in England, a radio telescope at Jodrell Bank uses a reflector diameter of about 250 feet, and in the United States near Delaware, Ohio, there exists an installation with a diameter of 700 feet). However, the West German radio telescope is a remarkable achievement because of the precision of the reflector construction and its bearing and of the servo technique employed.

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1. Telefunken-Zeitung, Telefunken GmbH, Berlin, Germany, vol. 113, 1956.
2. The Measurement of Thermal Radiation, R. H. Dicke, *The Review of Scientific Instruments*, New York, N.Y. No. 7, 1946, pp. 268-75.

Heat Insulators of Pure Gold

Atoms of pure gold are being used experimentally at Ford Motor Company to insulate automobile windshields and window glass against summer heat rays. Ford research engineers say that when glass samples are coated with a gold film 30,000 times thinner than a human hair, they filter out the sun's heat-producing rays but allow cooler beams of light to pass.

Ford researchers place gold foil and a sample of glass plate in a bell jar and then create a vacuum in the jar similar to that in a common radio tube. The gold is then melted electrically inside the bell jar. The gold "evaporates" in the vacuum and sprays atoms in all directions at speeds above 5,000 miles per hour. This puts a gold coating on the glass plate. While the atomic bombardment coats the glass, a light meter continuously measures the amount of light passing through the glass. The meter halts the depositing process before the coating becomes heavy enough to affect the transparency of the glass plate. Ford engineers say the coating process is halted when the deposit of gold atoms is 1,000 times thinner than a machinist's micrometer can measure.

Multiunit Neutralizing Transformers

T. F. PALMQUIST
ASSOCIATE MEMBER AIEE

IN RECENT YEARS there has been a large increase in the number of communication, telemetering, pilot wire relay, and other control circuits required by power utilities in Canada. Service continuity on these circuits is of prime importance, and neutralizing transformers are required in many cases to maintain this continuity and to prevent damage to the circuits or terminal apparatus as the result of ground potential rise.

Increases in the size of generating, transformer, and other power stations has resulted in consequent increases in potentials which may be applied to communication and control circuits serving a power station at times of fault on the power system. This has necessitated development of neutralizing transformers with increased neutralizing capacity. These transformers prevent excessive currents and voltages from being impressed on the circuits, thus preventing protector operation and possible circuit failure.

In Canada there have been projected circuit requirements of up to 100 or more circuits terminating in the larger generating stations. These extensive circuit requirements are usually associated with large hydroelectric developments, some of which form part of the St. Lawrence Seaway project.

Previously multiple installations of single-unit neutralizing transformers were used to provide the necessary protection. However, the transformers have large mounting space and complicated wiring requirements with consequent increases in costs and hazards. Multiunit neutralizing transformers are quite often a reasonable solution to problems of this type, inasmuch as the space requirements are much reduced and the wiring is simplified.

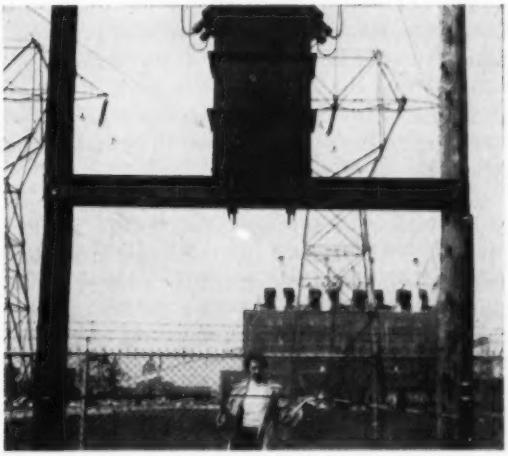

Fig. 1. Multiunit neutralizing transformer installation.

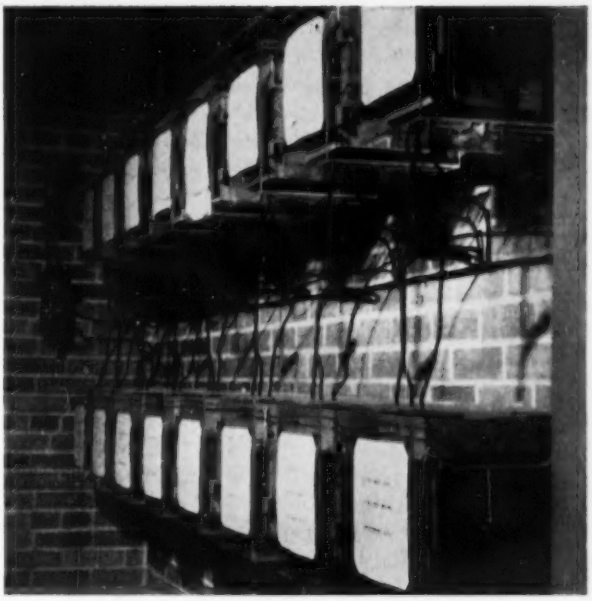

Fig. 2. Multiple installation of single-unit neutralizing transformers in tandem, showing plastic transformer covers.

Multiunit neutralizing transformers may be obtained in any size from about 2 to about 101 pairs. The primary and secondary windings of the transformer are wound parallel on the transformer core. In the transformer in Fig. 1, the primary winding consists of no. 8 AWG PVC (polyvinyl chloride) insulated wire, and the secondary consists of a 26-pair inside wire cable with no. 22 AWG conductors insulated with PVC, a core wrapping of two layers of 2-mil thick Mylar tape, and with a PVC outer jacket. Transformers of larger sizes than 101 pair are somewhat impractical, because the cable becomes quite large and difficult to wind and there is increased leakage reactance as the result of generally increased primary and secondary winding separations. Fig. 1 shows a typical installation of a 26-pair 5,000-volt neutralizing transformer mounted on channel beams supported by two poles. Fig. 2 illustrates the complexity of wiring and the large mounting-space requirements where a number of single-unit neutralizing transformers are placed at one location.

The impulse dielectric strength, transmission loss, and crosstalk performance of this transformer were determined by test and found to be quite satisfactory.

Digest of paper 56-929, recommended by the AIEE Committee on Wire Communications and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Fall General Meeting, Chicago, Ill., October 1-5, 1956. Published in AIEE *Communication and Electronics*, Jan. 1957 pp. 717-21.

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The Role of the Vacuum Switch in Power Applications

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MEMBER AIEE

The background of the vacuum switch is reviewed briefly with a view to the development of an improved concept of its capabilities and limitations in power switching. In addition, specific electric utility problems to which the vacuum switch currently seems to be applicable are proposed.

WITHIN RECENT MONTHS the vacuum switch, a device relatively unknown in the power industry until a few months ago, has attracted widespread interest throughout the utility industry. It seems appropriate, therefore, to review briefly the background of the vacuum switch and to propose specific electric utility switching problems to which the vacuum switch seems to be directly applicable, at the moment. Some ideas regarding future potential fields of application for the vacuum switch also will be briefly explored.

HISTORICAL BACKGROUND

IT IS DIFFICULT TO SAY exactly when the vacuum switch art began, because a search of the literature reveals extensive activity both in this country and abroad during the early part of the 20th Century and the latter part of the 19th Century. Specific patents relating to various aspects of vacuum switching can be found as early as 1893; in fact, a recent patent search has revealed a very thick book of patents which range in date from 1893 almost up to the present time. Furthermore, the patent application activity seems to have been quite large throughout this entire period of time.

In a relatively recent publication,[1] it has been stated that the first small vacuum switch was built commercially by the Swedish Birka Company in 1921. The extensive patent application activity prior to this date, however, makes it clear that developmental thinking in this field had been in process long before this date.

Much of the developmental work in the early days of the art was related to the switching of relatively small currents at reasonably small voltages. However, in the period around 1923, Sorensen and Mendenhall[2] began a series of extensive tests with the specific objective of determining, among other things, what possibilities existed with respect to switching the kinds of currents and voltages which are frequently encountered in electric utility operation. The work of Sorensen and Mendenhall was related to interruptions of currents ranging from 125 amperes up to 926 amperes rms at voltages ranging from 110 volts dc up to 41,500 volts ac.

There is little question that Sorensen and Mendenhall firmly established the fact that interruption of 60-cycle loads at frequently encountered power system voltages is within the realm of practicability. They concluded that a major limitation on the practicability of this activity was the problem, then unsolved, of "making commercial apparatus with vacuum tight joints, and the elimination of the use of liquid air with the vacuum pump."

During World War II, tremendous impetus was given to the development of improved vacuum switches by the need which arose in the radio industry for switching of high voltages in various types of atmospheric conditions. For example, much airborne radar apparatus necessitated the switching of relatively high plate supply voltages in atmospheric conditions that ranged from sea level pressures to pressures at altitudes in the tens of thousands of feet. Furthermore, this switching had to be accomplished in spite of wide variations in temperature and humidity conditions.

Similarly, the development of extremely high-power radio transmitters for the armed services radio activities, Voice of America activities, and other kinds of governmentally sponsored radio transmission programs subjected the available switching apparatus to extremely high-voltage requirements; yet these same problems were almost invariably fraught with limitations on the allowable size of the switching equipment to be used.

The result of this combination of demands for improved switching apparatus was that the vacuum switch manufacturers quickly availed themselves of the considerable amount of knowledge being developed in the field of making satisfactory metal-to-glass seals.

The development of the technique for accomplishing suitable seals between metal and glass also progressed at accelerated rates during the war years, because of the extensive use that the armed services made of combined metal and glass cathode-ray-oscillograph tubes, in which relatively large metallic surfaces had to be sealed to glass envelopes, etc.

The improvement in vacuum pumping techniques, which inherently accompanied the greatly accelerated Government procurement of evacuated components, coupled with similar improvements resulting from individual enterprise before and after the war, greatly reduced the troubles which early experimenters encountered in developing and holding a vacuum.

Closely related to the over-all problem of obtaining and holding a vacuum is the difficulty of suitably de-

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gassing the electrodes of a vacuum switch. One of the early patents relating to the vacuum switch art deals specifically and solely with a means of manufacturing a vacuum switch by a process which will result in what the holders of the patent claim will be a suitably degassed set of electrodes. The. performance of presently available vacuum switches satisfactorily attests the proficiency of modern degassing techniques.

THE MECHANISM OF INTERRUPTION

In spite of the extensive testing program which has been carried out by numerous different organizations in recent years, there still seems to be a dearth of specific knowledge regarding the fundamental mechanism of arc interruption in the vacuum switch under alternating-current conditions. Particularly, this seems to be true with respect to currents and voltages of magnitudes which can reasonably be expected in electrical utility systems.

Koller[1] conducted exhaustive investigations of the mechanism of arc interruption for d-c values ranging up to 30 amperes and 500 volts. His investigations revealed that regardless of how low a pressure exists in the switch enclosure prior to arc interruptions, the pressure will tend to reach an equilibrium value as loads are interrupted so long as the initial pressure is equal to or less than approximately 10^{-4} millimeters of mercury. The actual value of this equilibrium pressure is a function of several variables, including the material and size of the electrodes, the internal switch enclosure diameter, etc.

A rather profitable program of research might be one designed to establish the switch component dimensions which would result in an optimum combination of equilibrium pressure, life expectancy, and cost for a given set of performance conditions.

Koller discovered that as long as the vacuum is at least as low in pressure as 10^{-4} millimeters of mercury, the initiation of the arc as the electrodes are opened stems from the fact that, during the initial instant of opening the electrodes, the contact surfaces quickly deteriorate to points, and just immediately prior to breaking contact, there will be only one point of actual contact. Since all of the current transfer will be accomplished through this single point, the temperature of the electrode material will be raised very quickly to such an extent that vaporization will be quite rapid.

As the electrodes are separated further, almost immediately after separation (within approximately a microsecond) the extremely rapid rate of diffusion of the ionized metallic vapors will cause the arc to extinguish, and the metallic vapors will become deionized. As these metallic vapors move radially outward toward the switch enclosure walls and away from the original position of the arc stream, they constitute a gaseous material which, immediately after arc extinction, is available to be reionized provided that the necessary potential gradient can be established across them.

In a d-c system, Koller observed that, within approximately ½ microsecond after the initial arc extinction, a sufficient potential gradient was developed to reionize the diffusing vapors, and thereby to establish a new arc. Following this arc initiation, the cycle of interrupting and re-arcing seemed to repeat itself in a cycle which consisted of approximately 1 microsecond of arcing time followed by approximately ½ microsecond of extinction time.

These cyclic bursts of arcing seemed to continue as the electrodes of the switch were pulled further apart from each other, until finally the rise in voltage across the diffusing gases was no longer sufficient to reionize them to re-establish the arc.

Koller further observed that, in addition to this series of arc bursts, the interruption of some circuits may be accompanied by an additional breakdown phenomenon after the normal series of arc bursts has been completed. This additional mechanism is said to result from a recovery voltage across the switch which, after the initial series of arc bursts had been completed, establishes a potential gradient of such magnitude that re-ignition through field emission can occur. Koller observes that quite frequently this re-ignition through field emission phenomenon is immediately followed by a second set of arc bursts. It is suggested here that the foregoing additional breakdown phenomenon may, instead of being a true field emission mechanism, result from the ionization of minute quantities of residual gas which are absorbed in the hot contact surfaces as they cool after each extinction.

It seems almost fundamental that the mechanism of interruption outlined by Koller for the d-c case (in which currents of 30 amperes were considered large and voltages of 500 volts were the maximum employed) will not necessarily represent the total phenomena encountered in power systems involving large a-c voltages and currents.

For example, when the switch electrodes are subjected to bombardment by particles accelerated through potential gradients established by thousands of volts potential difference, and when these particles are available in such large quantities as would exist when currents may be as high as thousands of amperes, the effects of magnetostriction in reduction of the diffusion rate of the gaseous vapors, and the potentialities of radiation of vapor particles by the radiant energy liberated at the electrode surfaces will be factors which influence the interruption mechanism. It is possible, however, that all of the phenomena which Koller observed may be present even during high-voltage high-current a-c arc interruptions, but that they will simply be supplemented by other phenomena which are peculiar to high-voltage high-current a-c interruptions.

A HYPOTHESIZED MECHANISM

If the findings of Koller are combined logically with some well-established facts, a reasonable guess as to what happens during the interruption of a-c voltages and currents can be made.

Let it be assumed first that the interval being discussed in the following is confined to a single half cycle of the

current wave. Furthermore, let it be assumed that the system voltage is in phase with the system current so that throughout the half sinusoid being discussed the voltage across the switch will be in phase with the current through the switch, and a current interruption at the end of the half cycle will be accompanied by no transient voltages. Under these conditions, the interruption being studied is simply a direct-current case in which the voltage and current vary but at no time do they reverse in direction.

In order to facilitate subsequent discussion, let the terms "threshold voltage" and "threshold current" be defined as follows:

1. Threshold voltage is that potential difference across the vacuum switch which will produce sufficient acceleration of the gaseous particles in the arc stream to impart to them enough kinetic energy to result in high energy radiation as a consequence of collisions of these particles with other particles in the switch envelope or with the contacts.

2. Threshold current is that value of current which, as an arc between the vacuum switch electrodes, produces a magnetostriction effect (the constriction of the cross section of the arc column as a result of magnetic forces within the arc stream) that is relatively negligible in comparison to the diffusion effects resulting from the thermal energies of the gaseous particles in the arc stream.

It is immediately apparent, of course, that both of these threshold values are undoubtedly variables during the half cycle being studied because of the following:

1. The electrode separation will be a variable as a result of the fact that the switch contacts are actually being separated; consequently, a given potential difference across this separation will yield a different potential gradient within the interelectrode space at each instant of time.

2. Within the half cycle being studied, the actual current value will be variable; therefore, the thermal energy which exists among the various particles within the arc stream will also be subject to some variation.

If, during the half cycle being studied, the current and voltage crests never exceed their respective threshold values, it is probable that the phenomenon described by Koller will exist, except the relatively constant frequency of arc bursts and interruptions may not be so constant. This is just another way of suggesting that the half cycle being studied resembles a simple d-c case involving small voltages and currents as studied by Koller.

If the voltage during the half cycle being investigated reaches values in excess of the threshold voltage, then it is reasonable to expect that there will be present tendencies to maintain the vaporized particles in a state of ionization as a consequence of high-energy radiation, and the amount of such radiation is likely to vary in some way with the deviation of system voltage above the threshold voltage.

It is conceivable that such radiation might be present in sufficient quantity to reduce greatly or even eliminate the extinction time from the cyclic bursts and extinctions which were revealed by Koller.

Similarly, if the current during the half cycle being investigated actually exceeds the threshold current by an appreciable amount, it is conceivable that the cyclic extinctions observed by Koller might be eliminated from the mechanism of interruption as a consequence of the inhibition of diffusion which might result from excessive magnetostriction effects.

Logically, then, if both threshold voltage and threshold current values are exceeded during the half cycle under study, there would be an even greater probability of the elimination of the cyclic arc bursts which Koller observed to precede the final arc interruption.

In the more complex case involving interruption of the current in a circuit which is not operating at unity power factor, the foregoing hypothesis would be modified solely by the manner in which the circuit parameters influence the time relationships that exist between the periodic variations of magnetostriction effects, thermal energy levels, and potential gradients within the arc stream.

TEST RESULTS

A THIN THREAD OF CORROBORATION for the foregoing hypothesis seems to exist in the observed fact that in low a-c voltage and current switching applications, the current wave frequently appears on oscillograms to be chopped instantaneously to zero from whatever value it has at the moment the vacuum switch is opened. In such cases, the suggestion is that the system voltage and current are below their respective threshold values so the phenomena observed by Koller in the d-c case appear to be almost directly applicable.

Specifically, in tests conducted by the Hi-Voltage Equipment Division, Joslyn Manufacturing and Supply Company, in circuits involving maximum voltage and current values of approximately 440 volts a-c and 30 amperes a-c, respectively, this chopping phenomenon was present to such an extent that very high transient voltages were induced across the inductive components of the circuit. In fact, some of the transformer windings were actually punctured by the induced surges.

Oscillograms made during additional tests by this company in circuits involving voltage and current values of 15 kv and 750 amperes seem to be devoid of any evidence of such current chopping. Furthermore, during these tests, there were no apparent transient overvoltages generated since, without exception, the interruptions seemed to occur at normal current zeros.

Although the foregoing evidence is far from conclusive, it indicates some basic change in the mechanism of interruption as test voltages and currents are increased. The exact values of voltage at which the change would occur, for a specific test current and a specific switch, have not yet been established. Neither have the values of current been established for a specific voltage at which the change will occur. Certainly, from the standpoint of academic interest, these areas of study seem worthy of pursuit.

It is significant that extensive field studies have been in

progress for several months, and laboratory test programs currently are continuing at accelerated rates. Reports of many of these installations and test programs can be found in the technical press.[3]

The discussions which the various publications in this field have triggered seem almost invariably to be accompanied by extreme attitudes of optimism. While this enthusiasm is commendable and is, no doubt, evidence of the kind of vigor and drive which will ultimately be necessary to perfect the vacuum switch as a piece of standard electric utility equipment, it should be viewed, at this stage of the vacum switch art, with a cautious attitude.

There is little question but that outstanding performance records can be substantiated by actual test data in many instances. As a matter of fact, test results achieved by the Hi-Voltage Equipment Company on a single Jennings Radio Manufacturing Corporation type *R-8* switch are quite impressive; but if they are viewed without the necessary caution, they are likely to lead to an exuberance which can result in premature establishment of unwarranted operating ratings.

One such set of tests, for example, involved switching an inductive load of 750 amperes at 15 kv and 0.22 power factor repeatedly with the normal vacuum switch contact opening of approximately 5/32 inch. After repeated interruptions in this circuit, the contact opening of the vacuum switch was progressively reduced until a malfunction of the switch occurred. The malfunction occurred at a contact opening of only 0.020 inch. In other words this switch, which has since been superseded for many power switching applications by an improved model, successfully interrupted 750 amperes at 15 kv and 0.22 power factor lag repeatedly, with contact separations ranging from approximately 5/32 inch down to 0.020 inch.

After the restrike which occurred at 0.020-inch contact separation, the separation was increased to 0.031 inch. Repeated interruptions of the foregoing values were carried out successfully with no further evidence of internal restrikes. Fig. 1 contains several typical oscillographic representations of the vacuum-switch operations in the foregoing tests.

Certainly, this kind of performance tends to inspire enthusiastic acceptance, but it is imperative that it be taken into consideration that this was a single test specimen which very conceivably might have received a better-than-average degassing preparation and a better-than-average pumping cycle. Before any reasonable confidence in vacuum switch ratings can be established, a statistically significant sample of production-run units must be subjected to exhaustive tests.

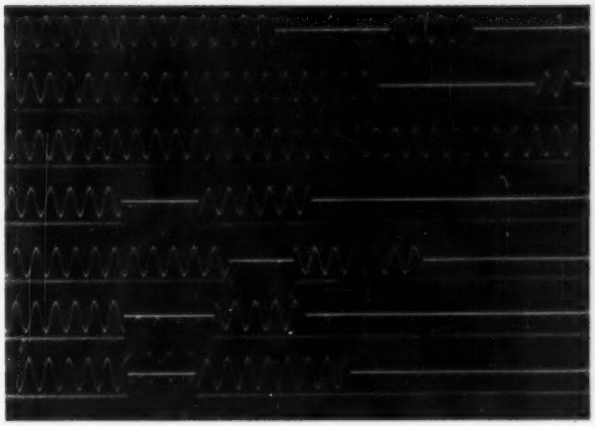

Fig. 1. Oscillographic recordings of vacuum switch interruptions of 13.8 kv, 600 amperes at 0.22 power factor, lagging. In each pair of traces, the top trace is voltage across the vacuum switch terminals and the bottom trace is the current through them. The third pair of traces represents a malfunction of the oscillograph and vacuum switch synchronizing circuits.

Table I. Proposed Interrupting Ratings of Jennings *R-9-G* Vacuum Switch at 15 Kv, rms

Operating Current, Amperes	Number of "Break Only" Operations	Number of "Make" and "Break" Operations
50	10,000	Rated at one half the number of "break only" operations shown at the left. "Make" current should be limited to twice the operating current, and severe contact bounce should not exceed 0.5 millisecond. For example, an *R-9-G* will make and break 400 amperes for 500 operations if the surge current on "make" does not exceed 800 amperes.
100	7,500	
200	5,000	
400	1,000	
600	250	
1,000	20	
1,500	10	
2,000	1	

At the present time, there is only one domestic manufacturer of vacuum switches with demonstrated abilities in the field of power switching. This manufacturer, the Jennings Radio Manufacturing Corporation, is presently supplying the vacuum elements for all vacuum switches being presented to the utility industry. As an example of the attitude of this company toward potential vacuum switch ratings, the data of Table I are presented. These data relate to the *R-9-G* vacuum switch which embodies numerous significant improvements over its predecessor, the *R-8*, which was the test specimen in many of the early field installations.

It must be pointed out that Table I does not present actual rating values which are currently considered final by the manufacturer. It simply represents the hoped-for ratings which, it is believed, will result from extensive laboratory testing routines currently in progress. Such testing routines must necessarily involve statistically significant samples before the values in Table I can be considered as established ratings.

It is of academic interest that, in testing to destruction, 2,500 amperes at 2,300 volts has successfully been interrupted 50 times with an *R-9-G* switch without appreciable visible damage to the switch. Here again this performance was that of a single unit, and whether continued testing will reveal this to be a reasonably expectable performance capability of this switch is yet to be determined. It seems of interest, however, that laboratory test routines are now approaching values which begin to encroach upon the capabilities of small fault-interrupting devices.

It is also significant that in arriving at the proposed values of Table I, Jennings has tested over 1,000 vacuum switches through a minimum of 50 operations each.

Many of these 1,000 units were subjected to as many as several thousands of operations, and one of them has interrupted 600 amperes at 18 kv and 0.7 power factor (lagging) approximately 5,000 times without damage.

APPLICATIONS IN UTILITY SYSTEMS

Before a decision can be made as to the kinds of switching problems which an electric utility might assign to a vacuum switch for solution, the specific technical and economic capabilities and limitations of the vacuum switch must be taken into consideration. Among the factors which deserve attention are its extremely high rate of rise of dielectric strength during a current interruption, its almost-complete freedom from maintenance requirements and its relatively high cost. In addition, the vacuum switch exhibits long-life characteristics, because of its freedom from such things as oil, which becomes polluted or oxygen, which tends to corrode its contacts.

Within the limitations imposed by the proposed ratings of Table I, it appears that the vacuum switch is capable of doing an excellent switching job in almost any utility application. More careful analysis of the facts, however, will tend to create an air of caution around the application of vacuum switches to the interruption of highly inductive currents. The very fast interruption of which it is capable and its occasional tendency to chop current waves, tend to produce very high transient voltages in the circuit being interrupted. In case of highly inductive circuits (for example, in the interruption of transformer magnetizing currents), the absence of extensive test data with which to inspire confidence justifies caution.

As additional testing proceeds and as more is learned about the exact mechanism of interruption in a-c cases, this need for caution probably will be eliminated. For the present, however, it seems essential that these highly inductive switching applications be approached with proper respect.

Detailed studies of the fundamental aspects of vacuum switch behavior in switching small inductive currents certainly could add much to present knowledge. There is some indication that this switch exhibits, more than might normally be expected, the properties of an oscillator in such switching applications. The distribution of its resonant frequencies and how they are related to normally expectable Q's of transformer primaries could be the subject of much study.

The extremely high rate of growth of dielectric strength in the vacuum switch during an interruption makes it almost ideally suited to the switching of capacitive loads, because this property of the switch gives it an excellent ability to eliminate restrikes and consequent system overvoltages which often accompany capacitive switching.

So far as the technical capabilities of the vacuum switch are concerned, it is ideally suited to switching all kinds of capacitive loads (within the limits established by Table I), but the high cost of the switch as it exists today virtually eliminates its applicability to small pole-top capacitor banks, such as might be encountered in a distribution system. The availability of small oil-filled switches at prices of a hundred dollars or so per phase, with which to switch pole-top banks of as much as a 1,000 kva at 15 kv makes the cost of presently available vacuum switches prohibitive in such applications.

As production quantities increase, and as the industry accrues the improvements in manufacturing techniques which almost inherently accompany such increases, the cost of vacuum switching equipment will be reduced. As this reduction develops, it seems quite probable that the vacuum switch will creep more and more into the field of automatic switching of pole-top capacitor banks.

In problems of switching relatively large station type capacitor banks (as much as 5,000 kva at 33 kv), the economics of a vacuum-switch installation seem a little more reasonable, and it is quite possible that in this field will come some of the very early field experience with these switches. A number of experimental installations in this kind of application are now being made, in addition to those which have been in service for some time; so it seems positive that within the next few months an impressive performance record under field conditions should be available for examination.

Another type of application which has been made by some manufacturers and which looks quite promising is in the field of line dropping. The problems associated with this type of application are well established, and the cost of using conventional oil-switch equipment, in such applications, are well known. In dropping long sections of high voltage lines, the vacuum switch not only has a distinct technical advantage over more conventional apparatus, but also it is likely to offer appreciable economic advantage.

So far as line sectionalizing devices are concerned (the field which presently seems to be covered by small horn-fiber devices), it does not seem likely that the vacuum switch will make great inroads in the immediate future. This observation is not based on an assumption of technical inability of the vacuum switch, but rather on the high cost of the device.

In spite of the extreme freedom of this equipment from maintenance requirements and in spite of its long life expectancy, it probably will be some time before installations can be justified economically in competition with horn-fiber equipment, which can be bought for prices ranging around $100 per phase.

It is significant that tests of the ability of the vacuum switch, in this category of switching, are currently in process in field installations of preproduction models, and no basic problems are anticipated. Nevertheless, these field installations are being made with the prior knowledge that economic considerations will probably preclude any future large sales volume in this category.

On the basis of presently available test data, it does not seem reasonable to expect that the oil circuit breaker will be replaced by vacuum equipment in the near future. Certainly, vacuum equipment has numerous technical and physical advantages over existing oil and air blast devices, but only the most meager of exploratory investigations have been conducted to date in the switching areas now covered by large circuit breakers.

As far as the small oil circuit recloser is concerned, in-

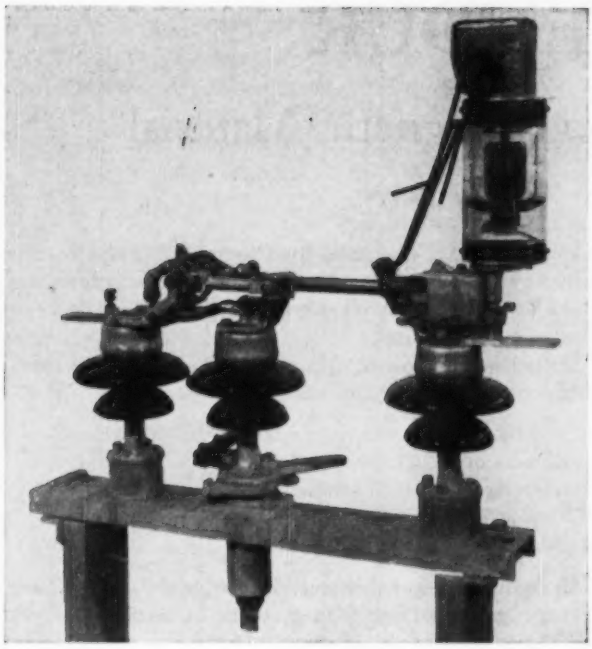

Fig. 2. One pole of a 15-kv gang-operated disconnect switch equipped with a vacuum switch interrupter unit.

vasion of its field by the vacuum device will probably not be very far into the future, but even here a great deal of developmental work will be necessary before any major inroads can be anticipated.

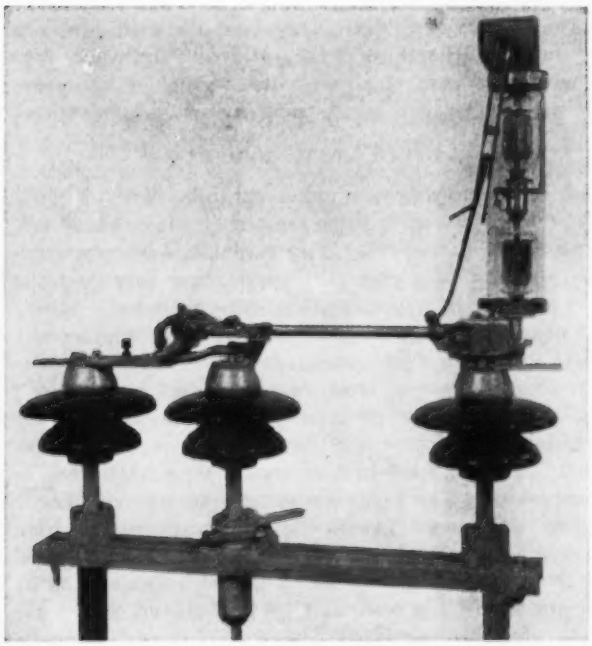

Fig. 3. One pole of a 34.5-kv gang-operated disconnect switch equipped with a vacuum switch interrupter unit.

Typical of the devices which are currently being developed in the switch industry are the experimental switches shown in Figs. 2 and 3. It is obvious from these illustrations that in this case the vacuum element has been attached as an accessory to one pole of a conventional gang-operated disconnect switch. In this form, the vacuum switch can be applied to a wide variety of utility switching problems without the necessity of acquainting operating and engineering personnel with any new installation procedures. In fact, this kind of equipment can frequently be installed even without modification to existing switch installation structures.

Additional embodiments of the vacuum switch for utility installation involve use of the vacuum element in a solenoid-actuated scheme, so attachment of this element to a gang switch is not contemplated. In this embodiment, the vacuum switch is simply arranged for mounting on crossarms or in any of the various manners in which currently available load-switching devices can be mounted. They can be provided either for solenoid operation in response to time clocks, relays, or supervisory commands, or for manual operation.

CONCLUSIONS

In summary, it can be said that the vacuum switch, as it is emerging from the radio industry into the utility industry today, has an extensive background of technological development. It certainly is far from being a new device, and its basic reliability is exceedingly well established in installations throughout the radio industry, many of which have been in service for over a decade.

Steps must be taken, in making the transition from well-established fields of wide application to the electric utility industry, which are essentially a series of somewhat tedious developmental projects. It is true that there are some modifications in fundamental thinking which are necessary in making this transition, but it is believed that these modifications will not be as time consuming as will be the tedium of the test programs that must be pursued in order to insure reliability.

The potentialities of the vacuum switch in the utility field seem large, but in order for these potentialities to become realities, it is imperative that current developmental programs be pursued to finality with a spirit of complete co-operation prevailing between representatives of the utilities and the switch manufacturing industry.

Assuming that a cautious and studied approach is made to each new step in the developmental process, and assuming that no member of the developmental team allows his enthusiastic exuberance at early successes to goad him into ill-advised test installations which exceed the present capabilities of vacuum switches, a certain and steady progress seems inevitable.

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SUPERMENDUR

A New Rectangular-Loop Magnetic Material

H. L. B. GOULD D. H. WENNY

Characteristics of Supermendur, a new vanadium-iron-cobalt alloy with exceptional magnetic properties, are discussed. Advantages include low coercive force, low hysteresis loss, high permeability, and high remanence. This material promises to be of value in telephone receiver diaphragms, miniaturization, high-temperature applications, and switching and memory devices.

IN RECENT YEARS there have been many new developments in ferromagnetics. Among them are noteworthy achievements such as Supermalloy and the ferrites. However, the absence of any recent improvement in magnetic materials for power work was apparent, inasmuch as the introduction of grain-oriented silicon steel had occurred more than 20 years ago.

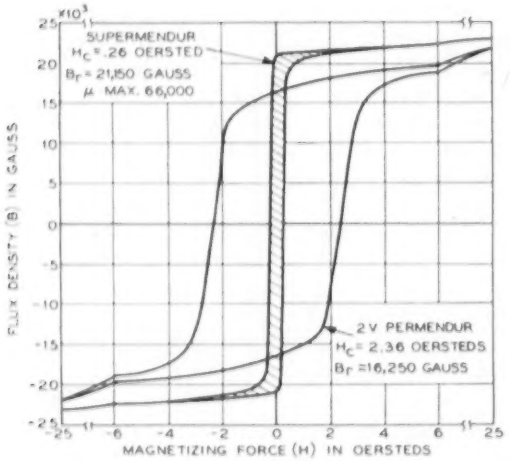

Fig. 1. Hysteresis loops of 0.004-inch 2V Permendur and 0.004-inch Supermendur.

This article presents the status of a new material which we have called Supermendur. It is a purified vanadium-iron-cobalt alloy with exceptional physical and magnetic properties.[1] Of a number of compositions prepared to date, the best characteristics have been obtained with 2% vanadium, 49% iron, and 49% cobalt. Previous to this investigation, considerable work on Fe-Co alloys was done for the U. S. Army Signal Corps by the Allegheny Ludlum Corporation.

Experimental lots of Supermendur measured at room temperature gave the following magnetic results:

Maximum permeability—66,000 at 20,000 gausses
Remanence—21,150
Coercive force—0.26 oersted
Saturation—24,000 gausses
Flux swing—45,150

It is significant that this material has established six new records in comparison with previous iron-cobalt alloys[2];

1. Lowest coercive force
2. Lowest hysteresis loss
3. Highest maximum permeability
4. Highest permeability associated with highest flux density*
5. Highest remanence*
6. A rectangular hysteresis loop with the greatest flux swing from minus remanence to plus saturation*

Because this alloy work hardens slowly, it can be cold rolled from 0.090 inch to less than 0.001 inch without intermediate softening treatments. For years hysteresis loss and poor malleability have been the main obstacles to the more general use of these alloys. With this development, the system of alloys with the highest saturation known can be used to advantage in many applications.

MELTING AND PROCESSING

AN ALLOY with a nominal composition of 2% V, 49% Fe, 49% Co was made using the highest purity vanadium, iron, and cobalt commercially available. These materials were melted in a controlled atmosphere furnace using wet and dry hydrogen, and cast into an ingot weighing 25 pounds. The raw materials and the melting procedure were selected with the utmost care in order to minimize the concentration of interstitial impurities in the alloy.[3] It is important that purification be accomplished in the melting stage because this alloy system has a phase change that limits the final heat treatment to a relatively low temperature. This is in contrast to other soft magnetic alloys which can be purified by a heat treatment at high temperatures after all processing is completed. Chemical analyses of the 25-pound melt reported a composition by weight of 1.96% vanadium, 49.97% iron, and 48.77% cobalt which is within the limit of error of the analytical methods of the 2% V, 49% Fe, and 49% Co

Essentially full text of a paper presented at the Conference on Magnetism and Magnetic Materials, Boston, Mass., Oct. 17, 1956.

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* New highs compared with all magnetic materials.

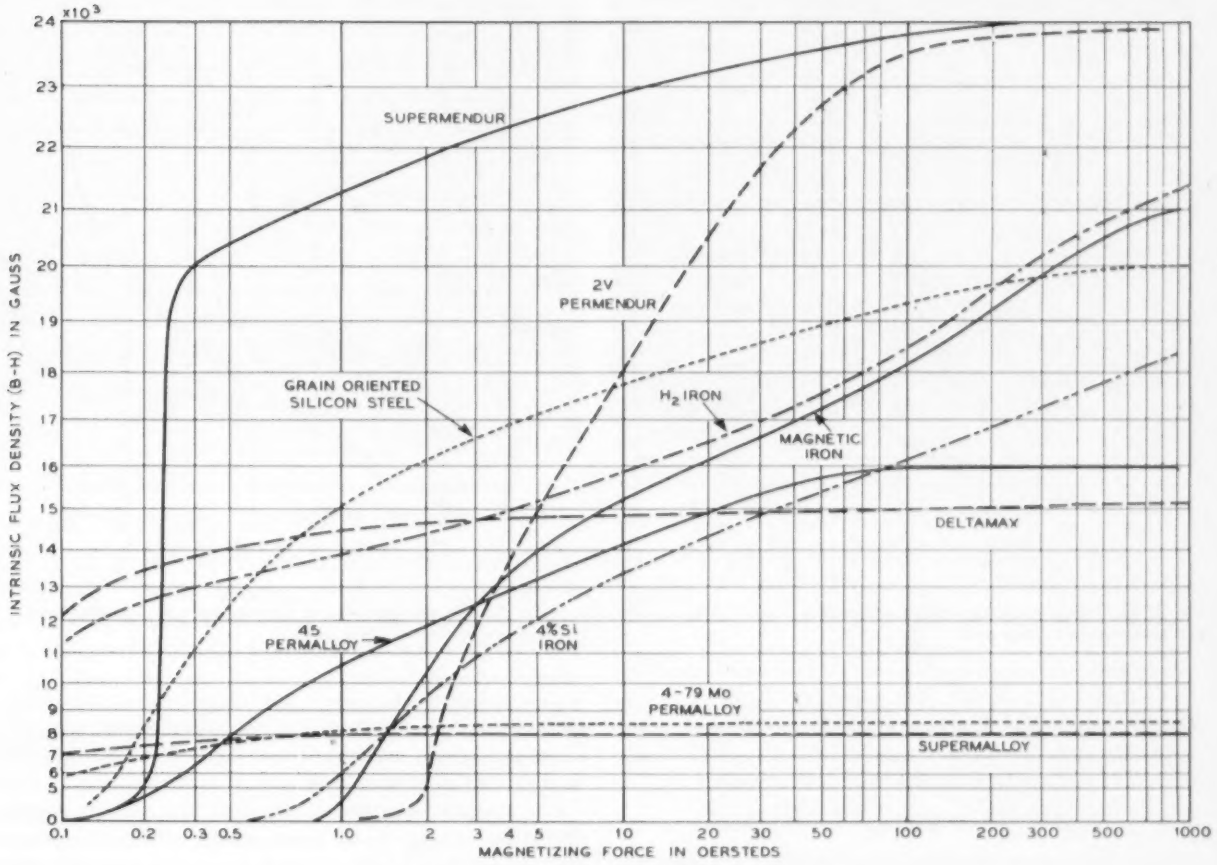

Fig. 2. Magnetization curves for important magnetic materials.

desired. The carbon and sulfur contents were less than 0.01%. The spectrochemical qualitative determination reported only faint traces of aluminum, calcium, and copper.

The ingot was hot rolled in two stages as follows: first, reduction at 1,200 C from 1½ inches to ½ inch; and second, reduction at 1,000 C from ½ inch to 0.090 inch. At this size, the strip was quenched in ice water from 910 C to obtain a malleable structure for cold rolling to the desired thickness.[4] Good cold-rolling characteristics are vital to the processing of vanadium permendur because many applications require cold reduction to thin gages. This type of alloy, as normally produced, is difficult to process and invariably needs several softening treatments for rolling to thin gages.

The response of Supermendur to the quenching treatment is very effective. It develops a malleability which persists and permits a cold reduction of 99.6% from 0.090 to 0.0003 inch without intermediate anneals. For the first time, an iron–cobalt alloy is available at a thickness of less than 0.001 inch. This severely cold reduced strip is ductile and can be bent back on itself without fracture. For heat treating and testing, the material was cold rolled to thicknesses of 0.004 inch, 0.002 inch, and 0.001 inch, insulated with magnesium oxide, and wound into toroidal cores.

HEAT TREATMENT

IT HAS BEEN ESTABLISHED that the purity of the hydrogen used in the annealing process is extremely important to prevent contamination. The temperature, time, and cooling rate are not critical, provided they are reasonably controlled. The heat treating temperature should be below the alpha–gamma transformation point (approximately 850 C). If this transformation temperature is exceeded, the magnetic properties are degraded by a phase change. The time at temperature should be of sufficient duration to remove strains and to promote grain growth and purification. A normal cooling rate of approximately 1 C per minute is suitable. A very fast cool or quench may produce strains in the material and a very slow cool may produce an excessive amount of ordering. Either of these produces a material with inferior magnetic properties. For optimum properties the final heat treatment should be in a magnetic field of 1.0 oersted or greater. Since the Curie point is not exceeded in the final heat treatment, any residual magnetism present in the core material is retained and has the effect of an applied field. The intermediate quality obtained thereby may be adequate for some applications.

The toroidal samples of tape were heat treated for various periods of time in dry hydrogen at temperatures

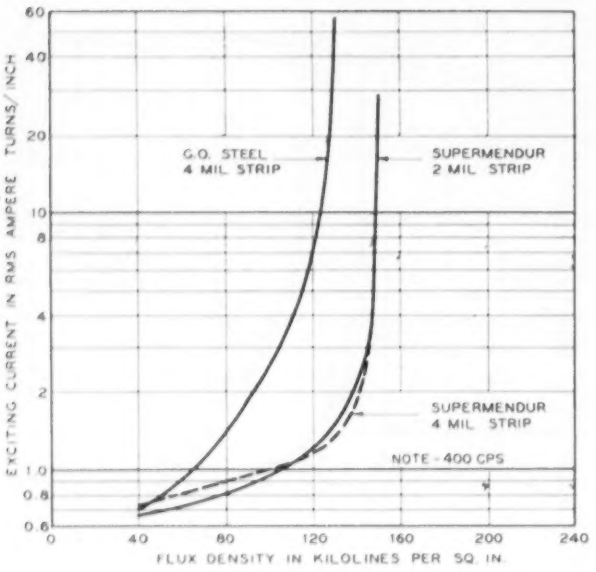

Fig. 3. Exciting-current characteristics of toroidal cores of Supermendur and grain-oriented silicon steel.

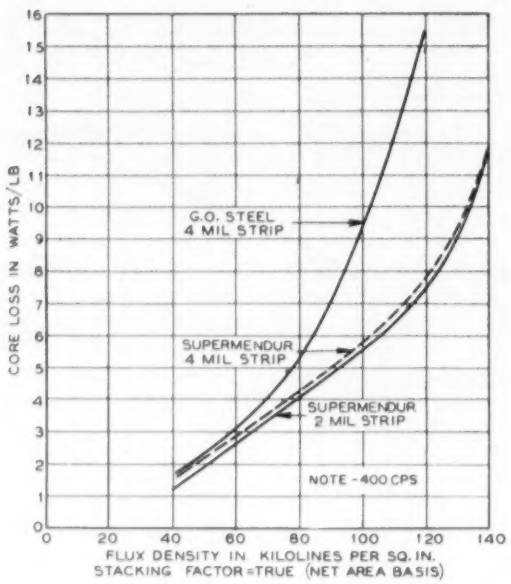

Fig. 4. Loss characteristics of toroidal cores of Supermendur and grain-oriented silicon steel.

slightly below the alpha–gamma transformation point (approximately 850 C). A magnetic field of approximately 6 oersteds was applied during the heat treatment.

TESTS

The magnetic properties of the samples were obtained from hysteresis loops taken with a Cioffi recording fluxmeter.[5] The coercive force and remanence of samples at three thicknesses are given in Table I.

Hysteresis loops for 0.004-inch Supermendur and 0.004-inch ordinary 2V permendur are compared in Fig. 1. The low coercive force and high remanence clearly establish Supermendur as an improved magnetic alloy. Typical *B-H* curves for Supermendur and other commonly used magnetic materials are shown in Fig. 2. A quadratic ordinate is employed to expand the scale. It shows Supermendur in the area of the *B-H* plot which was unoccupied by any magnetic material. These new properties should be a boon to design engineers interested in reducing the size of power coils. Excitation and core loss curves for toroidal cores of 0.004- and 0.002-inch Supermendur and 0.004-inch grain-oriented silicon steel are given in Figs. 3 and 4. These curves which are used to evaluate transformer core material indicate that coils with these Supermendur cores would have approximately 30% more power output than coils having grain-oriented silicon-steel cores of the same size. They also indicate that the advantage on an ampere turn excitation basis would be even greater percentagewise.

For magnetic amplifiers, the high flux density means that their size can be decreased about 20% for the same output. The precipitous sides of the hysteresis loop means that their gain can be increased by as much as 80% compared with amplifiers which currently use grain-oriented silicon steel. In circuitry requiring high amplification, this increase in gain makes it possible, in some cases, to reduce the number of stages from two to one.

Table I. Properties of Supermendur at Different Thicknesses after Heat Treatment in a Magnetic Field

Thickness, inches	Coercive Force, oersteds	Remanence, gausses
0.004*	0.26*	21,150*
0.002	0.30	21,400
0.001	0.47	21,500

*More recent values: $H_c = 0.20$ oersted, $B_r = 22,150$ gausses, and $\mu_{max.} = 92,500$ at $B = 20,400$ gausses.

STRUCTURE AND THEORY

The processing behavior and magetic characteristics of vanadium–iron–cobalt alloys are controlled by their purity. The excellent properties obtained with Supermendur are a direct result of the high degree of purity obtained with this composition.

Correlations between the structure of this material and its physical characteristics is not clearly understood. According to the constitutional diagram, cooling iron–cobalt alloys from the molten state involves not only a phase transformation of the face-centered cubic structure (gamma) to the body-centered cubic structure (alpha), but also an order-disorder change.[6] X-ray analysis of Supermendur shows only the presence of the alpha phase in this malleable material at room temperature.

After the final magnetic heat treatment, the material consists of relatively large grains. X-ray analysis gives no evidence of texture. In other words, Supermendur is not grain-oriented when annealed in a magnetic field. Oxides having a spinel structure (ferrites) have been detected in the material by electron diffraction, but to what extent they are present and the nature of their effect on the

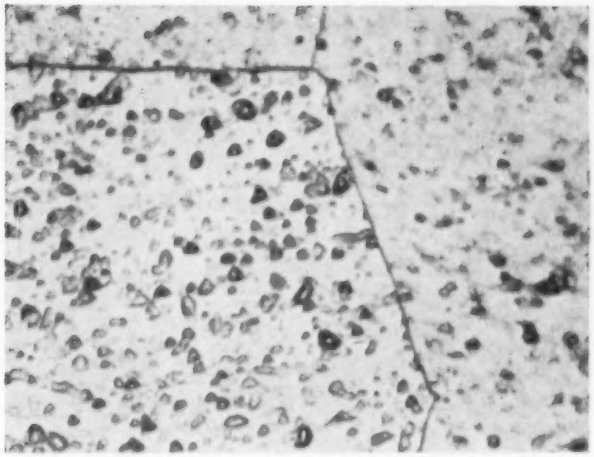

Fig. 5. Supermendur, 0.004-inch—annealed structure.

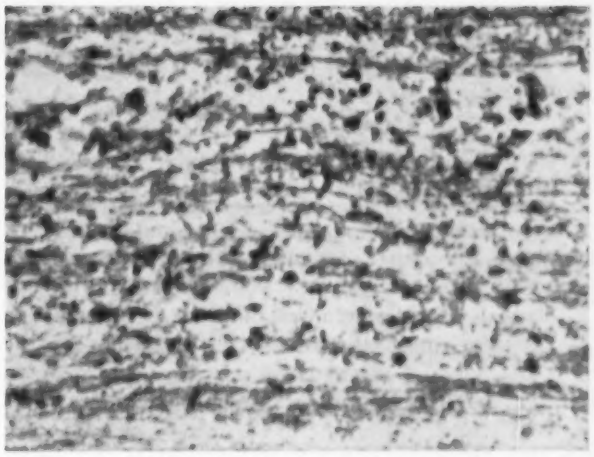

Fig. 6. Supermendur, 0.004-inch—rolled structure.

properties of the alloy have not yet been determined.

Magnetic powder patterns of the annealed material show magnetic domains oriented in the direction of the magnetization applied during heat treatment.[7] Figs. 5 and 6 are photomicrographs of annealed and unannealed 0.004-inch Supermendur. They show the fibrous texture oriented in the direction of rolling of the unannealed Supermendur and the large grains and random orientation of the annealed Supermendur. It is interesting to note that the grains in the annealed sample may extend clear through the lamination. These figures also show oxides dispersed in the crystals and their boundaries.

CONCLUSION

SUPERMENDUR, with its many desirable characteristics, should be particularly useful for power applications. Excellent rolling properties place it with the other soft magnetic materials and permit cold reduction to the thin gages so vital to modern requirements. Magnetic characteristics such as high flux density, low hysteresis, low coercive force, high remanence, high permeability at high flux density, rectangular hysteresis loop with perpendicular sides, and high Curie point should be of considerable value in meeting the demands of design engineers.

At the present stage of development, this material appears to have advantages for use in power transformers, pulse transformers, magnetic amplifiers, telephone receiver diaphragms, and switchings and memory devices. Supermendur answers the need for an outstanding magnetic material at high flux density and should become a valuable addition to the list of important magnetic materials.

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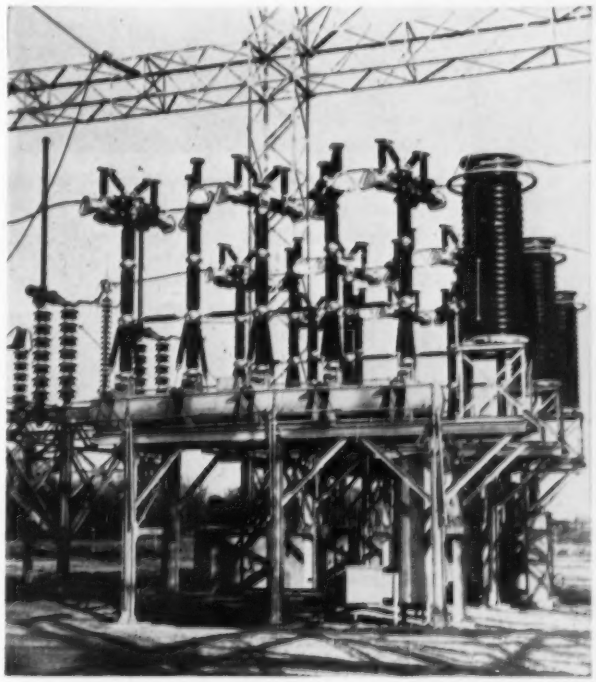
Air-Blast Circuit Breaker



This 330-kv air-blast circuit breaker, the largest ever installed in the United States, was manufactured by the Brown Boveri Corporation, New York, N. Y. Operating in the Lima, Ohio, plant of the Ohio Power Company, it is one of two such breakers in the American Gas & Electric System.

A Modern Industrial Laboratory

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MEMBER AIEE

Industrial laboratories are playing an increasingly important role in providing manufacturers with information needed in the design, development, and production of better products. The function and operation of the General Electric Company's new Industry Control Laboratory are described.

THE GROWTH in number and size of industrial laboratories is an indication of the important part they play in a progressive industrial enterprise. Not only do manufacturers rely on laboratory tests to evaluate their products, but also many users make tests in their own laboratories to determine which manufacturer's product they will purchase. The old adage, "One test is worth a thousand expert opinions," indicates the importance which people attach to experimental data.

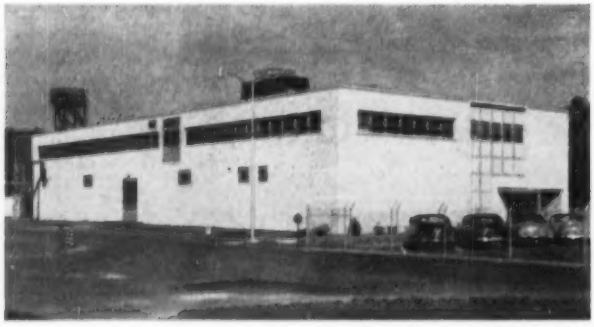

Fig. 1. General Electric Company's Industry Control Laboratory, located in Roanoke, Va.

The modern industrial laboratory is a service organization with facilities for supplying the engineering and manufacturing sections with the information they need to design and build better products. The service includes supplying to the engineering section the evaluation of products, application data, and consultation services; and to the manufacturing section, the quality control of incoming materials, regulation of processes, and maintenance of measurement standards.

The new laboratory of the industry control department of the General Electric Company in Roanoke, Va., provides all the facilities necessary to carry out these functions. It is designed to meet the operating requirements of the department. Close liaison is maintained with other department laboratories and also the General Engineering Laboratory and the Research Laboratory which serve the company as a whole.

The laboratory building is a 2-story fireproof structure of modern architectural design as shown in Fig. 1. The dimensions are 75 by 150 feet. The first floor is divided longitudinally into three sections: (1) offices; (2) evaluation laboratory and model shop; and (3) life-test area, generator room, high impact shock room, and circuit-interruption area. The third section is separated from the other two by a double-thickness brick wall to prevent noise generated in these areas from penetrating to the other sections.

Fig. 2 is a photograph of the plug board and mimic bus which, by means of color-coded lines and indicating lights, shows power distribution and utilization in the building. A glance at the board tells whether a given source of power is energized and, if so, at what location it is being used. Plug lines to all areas of the laboratory provide versatile power distribution.

In the evaluation of a-c and d-c contactors, interruption tests are made at current levels far in excess of the rated current. The transformer to supply this power has a short-time rating of 2,400 amperes at all standard voltages from 115 to 550 volts, three phase, with taps from 95 to 130 per cent in 5 per cent steps. For testing overload relay heaters in combination with protective means, a current of 10,000 amperes is available. D-c power for circuit interruption is obtained from a water-cooled ignitron type mercury-arc rectifier. Current of 15,000 amperes at 600 volts or 25,000 amperes at 300 volts is available from this source. Primary taps provide a range of adjustment from 83.5 to 110 per cent of these voltages.

A portable copper oxide rectifier with a continuous rating of 5,000 amperes, 6 volts is used for heat runs and checking trip settings of overload relays. Smooth stepless control of voltage and current is obtained by means of an adjustable saturable-core reactor. By suitable reconnection of the output, voltages up to 24 volts can be obtained at a corresponding reduction in current.

Bench tests on a wide variety of devices are made in the evaluation laboratory. For rating contacts on their ability to interrupt control circuits, banks of d-c contactors and a-c contactors are available. Adjustment of current is obtained by paralleling coils, making certain that only like coils are connected together. Operation tests on contactors, speed of opening and closing, pull and load data, heat runs, and other pertinent data obtainable on a bench test setup are made in this location.

The problem of procuring hand-made samples or prototypes of future designs has been assigned to the laboratory rather than the factory toolroom. To make these devices, a model shop has been set up, incorporating the

A special article recommended for publication by the AIEE Committee on Industrial Control.

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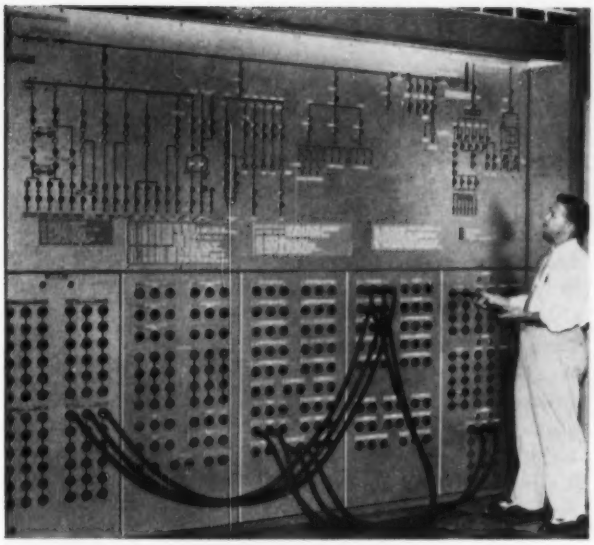

Fig. 2. Mimic bus and plug board.

usual type of machine tools. Here the designers follow closely the manufacture and assembly of those prototypes.

The second floor of the laboratory has facilities for the chemical–metallurgical unit, a darkroom and studio for photographic work, an instrument standardization room, ambient temperature rooms, and a circuit development area. Office space is provided for people doing advance engineering work. The chemical–metallurgical unit works closely with the manufacturing organization. Here tests are made on samples of materials purchased from vendors to insure quality before release to the factory. In this way, time and money is saved by avoiding factory operations on substandard material. Fig. 3 shows an electroanalyzer for quantitative analysis of alloys. Plating solutions are analyzed and recommendations made on corrective action to be taken to insure good quality of plated parts. Facilities for testing gloss, abrasion resistance, adherence, and thickness of paint samples are available. Salt spray and humidity cabinets are used to evaluate resistance of finishes to corrosive atmospheres.

In the metallurgical laboratory, equipment is provided to make photomicrographs of metals to study grain structure. A 60,000-pound tensile tester, a spectrograph for analysis, heat-treating furnaces, and hardness testers are also available in this area.

Photography plays an important part in documentation in an industrial plant and laboratory. A darkroom and studio in the laboratory are equipped to take care of all the photographic needs of the department, including engineering, publicity, advertising and sales promotion, and manufacturing. A high-speed movie camera, capable of taking pictures at the rate of 3,000 frames per second, has an extra lens which permits recording traces from an oscilloscope screen at the same time and on the same film that records the mechanical motion. Thus, the mechanical and electrical effects can be studied simultaneously.

Fig. 4 shows the calibration console which supplies regulated a-c and d-c voltages and currents suitable for calibrating instruments. This is done from secondary standards which, in turn, are calibrated using a standard cell and precision potentiometer. A portable source of power is used to calibrate permanently mounted instruments located in the factory. Process instruments throughout the plant are calibrated and serviced by laboratory personnel.

Industry control equipment should be capable of performing satisfactorily in a 40 C ambient according to NEMA (National Electrical Manufacturers Association) standards. While the temperature rise of coils, shunts, and contacts is about the same whether the heat run is made in a 25 C or 40 C ambient, the trip current of temperature overload relays is affected by ambient temperature just as the amount of load an electric motor can carry is affected. Hence, overload relays are always rated in a 40 C ambient. To facilitate this work, a room approximately 10 by 12 feet is maintained continuously at this temperature. Controls are arranged so that once the

Fig. 3. Electroanalyzer for alloys.

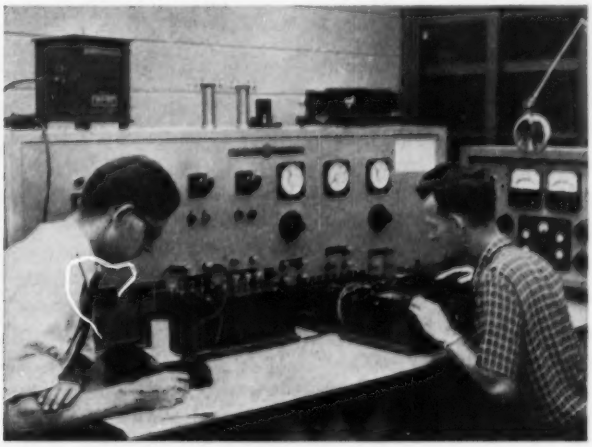

Fig. 4. Instrument calibration console.

relay is mounted in the room, all other work incident to rating it can be carried on from a control desk outside the room. In the laboratory, there are four manual rating circuits and four automatic rating circuits ranging from a fraction of an ampere to 1,000 amperes. Fig. 5 is a view of the automatic rater. With this equipment, the exact current necessary ultimately to trip the relay is found by connecting the relay in the circuit and setting the controls. The current is automatically raised in increments until the relay trips and is then reduced until the "no trip" or "hold" current is reached. This process is repeated for the length of time the controls are set, at which time the power is turned off. The record of trip and hold currents is indicated by a recording instrument.

In the design of circuits to control cranes and hoists, it is advantageous to have a means of checking the actual performance against the calculation. This is especially true to get the "feel" of the control for spotting heavy loads and to check the timing and holding power of the brake. To do this, a full-scale crane tower equipped with motors and control designed for quick change has been constructed. This is shown in Fig. 6. Between the motor

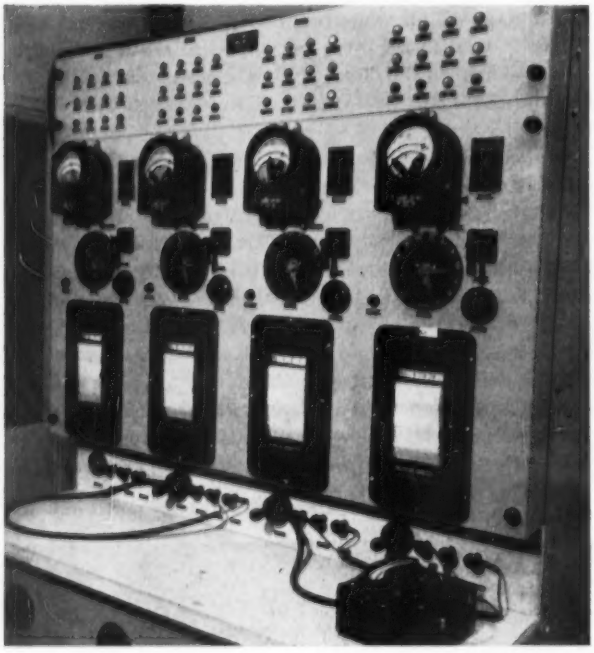

Fig. 5. Automatic rater for temperature overload relays.

shaft and gearing is a torque-measuring device which indicates torque directly on a meter. A selsyn provides continuous indication of the position of the hook.

In the organization of the engineering section, the laboratory is one of seven subsections reporting to the manager–engineering who in turn reports to the general manager of the department.

Many new facilities have been added to handle the additional services required in a decentralized location. All old equipment has been overhauled and modernized to blend with the new equipment.

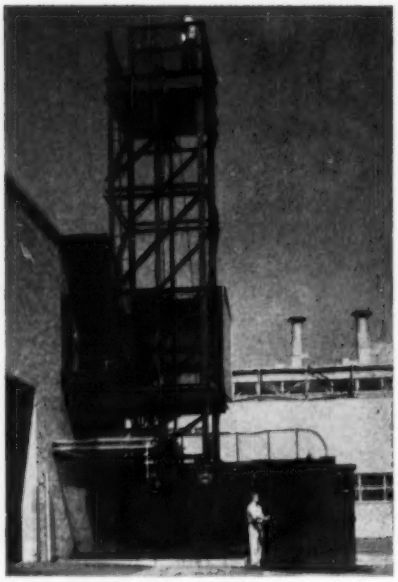

Fig. 6. Crane tower.

Thus, the Industry Control Laboratory is equipped and staffed to provide the modern, scientific approach to technical problems of the department. Its active participation in the business will also make for greater progress in the entire industry.

Radar for *USS Gyatt*

The radar guidance equipment designed and built by the Reeves Instrument Corporation, a subsidiary of Dynamics Corporation of America, for the "Terrier" missile system installed aboard the *USS Gyatt*, the U.S. Navy's first guided missile destroyer, commissioned on Dec. 3, 1956, at the Boston Naval Shipyard, combines a gun fire control system with radar guidance equipment.

A slim needle-nosed supersonic weapon, the "Terrier" is designed to intercept aircraft under all weather conditions and by night as well as by day. While similar to the radar guidance equipment installed aboard the cruiser *USS Boston*, and earlier models developed by Reeves for the *USS Mississippi* and converted seaplane tender *USS Norton Sound*, it is more compact, has greater range and precision, and is capable of self-monitoring.

When the approach of an unidentified plane is indicated on the radarscope, certain signals are generated which identify the plane as friend or foe. If the approaching aircraft is identified as an enemy plane, the radar continues tracking the target, and relays necessary information to the missile-launching computer for the firing of the missile being used to shoot down enemy planes. A closely interrelated data system between the radar, the launcher, and the missiles itself then shoots the missile into the radar beam and the missile is guided by the radar to intercept and destroy its target.

A New Line of Protective Relays and Cases

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MEMBER AIEE

W. E. GLASSBURN
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THE RAPID GROWTH in the utilization of electric energy and the importance of continuity of service has increased the application of protective relays. This magnifies the problems of space, which is already at a premium in many existing stations and an increasingly costly item in new stations. A critical examination indicated that considerable savings in space could be effected in many of the relay designs and still improve accessibility to the relay operating units. Consequently, a major redesign program was undertaken to provide these advantages and also to incorporate many other technical improvements. Along with the concept of reduced size, other important concepts were given renewed emphasis in this redesign program. These were (1) designs built around a minimum number of standard basic units, (2) self-containing each relay type within the relay housing, (3) unit designs of self-aligning parts, (4) minimum adjustments, and (5) designs for universal application to reduce varieties. These concepts form the basic design philosophies underlying the new lines of relay cases: the induction-time overcurrent, directional-time overcurrent, and induction-time voltage relays described in this article. The results are compact modern protective relays of reliable performance and minimum maintenance.

The new Flexitest (registered trade mark) relay cases are approximately two thirds the previous height, with the width and the horizontal spacing of the test switches remaining the same. Thus, existing test facilities can be used with either design. At the same time, the appearance has been modernized and the number of cases reduced from six to four. This includes one new small size, with the three other sizes having the same panel cutout dimensions as previously. Three sizes, including the two larger sizes, have been eliminated. This not only offers considerable advantages in space saving on switchboards, but also facilitates layout through reduction in the number of sizes the designer must arrange on the panels.

At the same time, for the equivalent external size, the internal relay unit mounting space is increased, making it possible to reduce the relay size for a given type or to self-contain auxiliaries now mounted externally. The advantages are lower costs, both in switchboard wiring and maintenance testing.

This additional space is obtained by (1) designing the case approximately ¾ inch deeper, (2) eliminating the flexible wiring and case terminals directly behind the relay units, and (3) shortening the knife-blade test switches.

Additional features are (1) universal semiflush or projection mounting, (2) a modern plastic cover with a molded neoprene gasket for a positive dust seal, (3) a separable cover hinge with one cover nut fastening, and (4) visibility of contact devices with the relays in service.

The entire relay line previously existing in the Flexitest cases is available in these new cases.

The E-unit induction-disc relay has been reduced in size and extended to a complete line of current and voltage relays mounted in the new small case. The size reduction of the E-unit was realized by rearrangement of the principal components without reduction in size or torque level of the torque-producing components.

The same time–current characteristics have been retained with a general decrease in burden. For the definite-time, long-time, and moderately inverse-time characteristics, the burden is reduced from 17 to 4 volt-amperes at tap value current. For all relays, the self-heating error is negligible, and gears are not used to provide any timing range, including the long-time characteristics.

The same E-unit has been utilized to give the voltage-relay characteristics. The resulting curves are the same as those formerly provided. There are several varieties, including the overvoltage and undervoltage, both long and short time, as well as a low-voltage pickup overvoltage relay for generator-winding ground-fault detection.

A newly designed cylinder unit used as a high-speed directional unit has been co-ordinated with the new E-units and housed in a new smaller size case. This combination results in a complete line of self-contained reduced-size relays for phase, ground current-polarized, ground voltage-polarized, and ground dual-polarized, directional-overcurrent protection. The directional unit consists of a four-pole electromagnet surrounding a cylindrically shaped rotor. With a cylinder, the metallic area on either side of the electromagnet air gaps has been equalized so that the vibrational forces at high energy levels are negligible.

Inasmuch as it is impossible to manufacture a device with 100-per-cent symmetry, spurious forces will be present. A practical adjustment to neutralize these forces is obtained by two magnetic plugs in the electromagnet. This micrometer-type adjustment insures straight-line phase-angle characteristic over a wide energization range.

New single-unit indicating-contactor switches and indicating-trip attachments have been designed to replace the previous designs of two separate units for each type. These provide gravity-drop resettable targets. The actuation of the targets does not change the pickup setting nor impair proper contact action. Resetting the targets cannot cause accidental contact closure. The instantaneous trip unit has a 4-to-1 pickup range with a drop-out to pickup ratio of 65 per cent at minimum setting, increasing to 90 per cent at maximum setting.

Digest of paper 57-18, recommended by the AIEE Committee on Relays and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N. Y., Jan. 21-25, 1957. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1957.

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Digital Telemetering and Print-Out of Pipeline Information

M. T. NIGH

The "how" and "why" of a new method of telemetering in the pipeline industry, using supervisory or centralized control equipment, is described. Digital telemetering offers considerable promise in terms of accuracy, reliability of data transmission, minimum communications channel requirements, and ease of utilization of data in retransmission or computation.

THE TREND toward closed system pipelines and remote control has brought many new improvements in the pipeline industry. However, with these innovations have come problems. Remote operation of pipeline machinery necessitates bringing a great deal of information to a controlling point from the "satellite" stations. Transmission and display of this information for best utilization is a subject of interest to all pipeline engineers.

DEVELOPMENT

IN THE PAST, the most common method of telemetering pipeline information has been the time-impulse method. This method involves keying a narrow communication channel for a length of time proportional to the amount of the measured variable. The on and off time periods are complements of each other and establish a definite proportional position of a pointer at the dispatching station. Another system varies the frequency of a signal imposed on the communication channel proportional to the measured variable. These methods, in effect, are analog methods as opposed to digital methods of transmission. To better define the terms "analog" and "digital" one may compare a slide rule, which is an analog machine, to a Monroe or Marchant calculator, which is actually a digital or coding machine. The slide rule is approximate; but the calculator is exact within the limits of its structure. The centralized control system discussed in this article is essentially a digital system.

With the analog type of telemetering system, the accuracy of readings obtained is dependent upon the uninterrupted pulsing of the communication channel. Noise and signal interruption of any communication system whether microwave or wire line can contribute to inaccuracies in the measured result at the dispatch point. This may result in "wiping" or oscillation of the pen on an analog telemetering recorder. This instability, while recognized, gives concern to the dispatcher in observing changes in the measured variables.

This is in contrast to the security against false registry of information designed into a centralized control system which transmits the supervisory indications from the satellite station to the controlling or dispatch stations in some form of code steps. In supervisory control systems under discussion, the indications can be secured by any of the well-known methods such as use of redundancy, three out of five check and/or message totalizing. If incorrectly received, the system can be arranged to drop out the data before registry and ask for a repeat until the data is obtained correctly. This security of data against transmission error is very desirable and is necessary in a supervisory control system as the history of the art has shown.[1]

It is necessary in approaching a supervisory or centralized control system to increase its workload for telemetering, to consider the duty time in pipeline operations. The scheduling of oil movements in pipelines is usually made on a weekly or monthly basis and, therefore, most machinery operations are made fairly rigid for a like or longer period. This is true whether the machinery is locally or remotely controlled. A corollary of this might be that the machinery has very few breakdowns or losses of power during such periods if properly engineered and maintained and, thus, few stops and starts are made. It follows that a standard supervisory control system in pipeline service gets very little use in comparison with its capacity for work as compared to the work obtained from most machinery in a pipeline system. With these points as background, it is easy to see why the incentive is created to make better use of the exceptional tool of supervisory control.

The equipment described subsequently is designed to reach the objective of using supervisory control equipment for telemetering as well as for remote control.

DESIGN

THE DIGITAL TELEMETERING IDEA was first applied by Service Pipe Line Company to a single 1,250-hp booster station on a 12-inch line connecting two stations with tankage in central Wyoming. This electric centrifugal station's local facilities and control equipment are considered to be good standard design in the pipeline industry and will not be discussed in this paper.[2] The communication link is 25 miles of telephone line, with all comunication channels for control and supervisory indications above 37-kc frequency.

Essentially full text of paper 57-38, "Digital Telemetering and Print-Out of Pipe Line Information," recommended by the AIEE Committee on Petroleum Industry and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N.Y., January 21-25, 1957. Scheduled for publication in AIEE *Applications and Industry*, 1957.

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The centralized control system for the "satellite" station provided for complete remote operation of the pumping unit. The following indications of machinery status are transmitted back to the controlling station: (1) pumping unit on; (2) pumping unit off; (3) suction valve open; (4) suction valve closed; (5) main breaker open; (6) low suction pressure; (7) communication circuit failure; (8) 50-psi station low air-pressure warning; (9) pump seal failure or high sump; (10) current unbalance or undervoltage; (11) high pump case pressure or case temperature or high discharge pressure; (12) and pumping unit fault (motor overload, motor bearing, motor winding temperature, motor lube oil pressure, trip battery, low voltage, pump vibration, 20-psi air pressure alarm).

Note that certain faults were lumped together to conserve cost in centralized control equipment and still provide all the necessary information for the most efficient type of operation from the controlling station.

Service Pipe Line Company has put a number of stations, similar to the "satellite" station described here, in service and have used time-impulse telemetering of suction, case, and discharge pressure and flow to the controlling station. With this analog system, six communication channels have been required, one for control codes, one for indication codes, and one each for the four measured variables. In some of these installations, it was necessary to use signal channels above 37 kc because of the number of telephone carrier channels occupied by voice communications. This made the requirement for repeaters necessary where any great distance was involved for the transmission. Where several stations are involved, or where leased wire facilities are the means of communication, the advantage of reducing the number of communication channels is obvious.

At this "satellite" station the number of communication channels were reduced from six to two by telemetering all the information of the measured variables on the same signal channel used for supervisory indications.

The programmer at the "satellite" station transmits each measured variable sequentially. At the controlling station, all these variables are stored and then printed out in sequence on the typewriter along with the time at which the telemetered data was requested.

Although only four measured variables are transmitted from the "satellite" station, a much greater number of measurements could be sent on the same channel with a small increase in the size of the programmer.

EQUIPMENT

In Fig. 1 is shown the control cabinet located at the "satellite" station, the typewriter, and the control cabinet located at the controlling station. Fig. 2 shows the rear of the control cabinet located at the "satellite" station. On the swinging panel are shown the programming timer and channel deriving units. Inside the cabinet from top to bottom are the heater, telemeter transmitters, coding unit, storage, and programming relays. In the bottom box the deviation and rate of change relays for discharge pressure and flow are shown.

The telemeter transmitters each consist of a pressure measuring system and an encoder. The pressure measuring system consists of a null balance servo-operated indicator with a differential transformer in the transmitter positioned by the bourdon tube or bellows. The servo motor is driven by the amplified error signal between the differential transformer in the transmitter and the differential transformer in the receiver. The encoder is a device that converts a shaft position into a digital output, in our case the indicator pointer shaft. This conversion is accomplished by 12 brushes riding on a code plate with alternate silvered and insulated spaces on its surface, establishing a binary code combination. This characterizes the measured variable in digital form. At the "satellite" station all measured variables are made up of three significant figures, and thus 12 output circuits are required to supply the binary bits to signify numerical values from 0 to 999. Four of the bits represent the "thousands" values, four bits represent the "hundreds" values, and four bits represent the "tens" values. Pressure and flow measurements could not be read closer than the nearest 10 pounds and, therefore, closer values are not transmitted. This is a very important design point. The greatest economy of transmission is obtained when no value is transmitted at a greater resolution than is possible to read at the "satellite" station. Measurements at the "satellite" station are made as accurately as possible. The accuracy obtainable with the telemetering measuring system is guarded by the code transmission system, and thus the registry of error is eliminated in the telemetering system. In Fig. 3 is shown the telemeter transmitter consisting of (from left to right) the encoder, servo motor and commutator (discussed later),

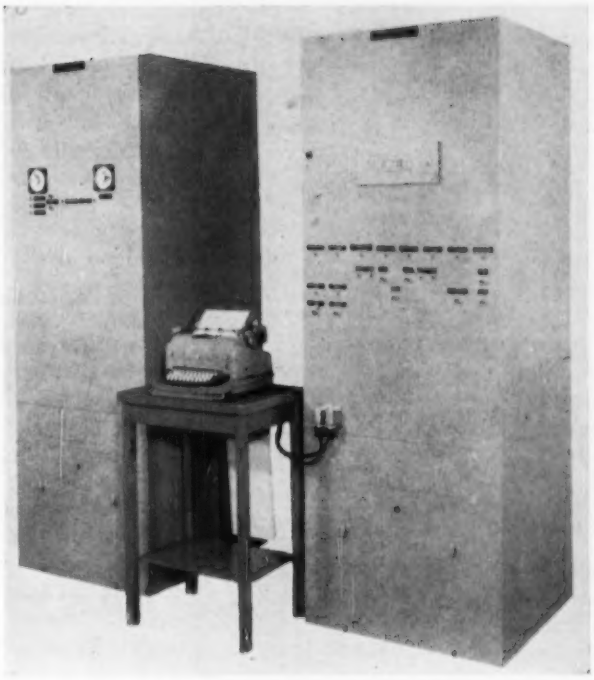

Fig. 1. Office and "satellite" station centralized control cabinets.

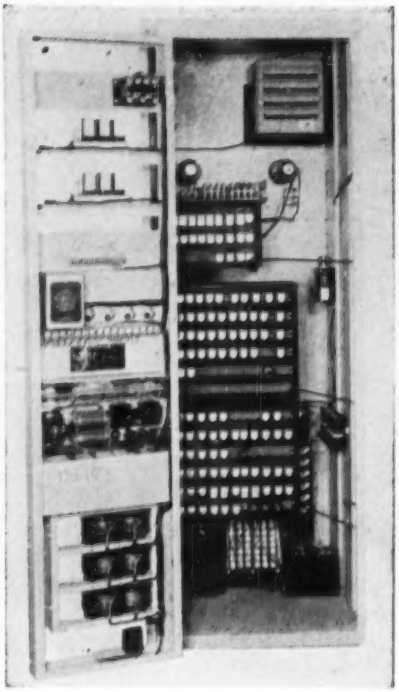

Fig. 2. Rear view "satellite" station centralized control cabinet.

and the measuring system receiver or indicator. The differential transformer transmitter is not shown; neither is the power amplifier for the servo motor. The servo motor shown in Fig. 3 receives its power from a magnetic amplifier measuring the error signal between the transmitter differential transformer and the receiver differential transformer. Industry, in general, is showing considerable interest in instrumentation of this type. It offers features which conventional air or electronic instrumentation do not possess; that is, null balance design with considerable power output to operate a number of devices, and a circuit involving vacuum tubes. A code plate is the most convenient method of obtaining output from a shaft position, and an instrument with power output is required to position the encoder.

Transmission of this digital data is accomplished in the same manner as all supervisory indications. The measured variable through the encoder is stored in 12 relay positions in the supervisory cabinet at the "satellite" station. These relay positions are transmitted as long and short pulses to characterize their position and at the office or controlling station the long and short pulses determine the position that certain relays, designated as storage, are to assume. When the code is received into the controlling station, it is stored in weighted decimal binary form. This means that the four bits which represent each digit are assigned weighted values such as 1, 2, 4, and 8. Various combinations of these four digits can determine any number between 1 and 10. A programmer now sweeps past this data in storage and thus determines which keys to operate on the typewriter. Table I shows a typical print-out record for the starting of a pipeline booster station.

Four methods determine the frequency of sending this information back to the controlling station:

(1) An adjustable timer 0–60 minutes) in the "satellite" station cabinet.
(2) The dispatcher at the controlling station asking for information by pushing a button.
(3) A counting circuit measuring the deviation from the previous reading (this is adjustable from 40–100 psi).
(4) A rate-of-change device which not only sent in the telemetered data, but also asked the typewriter to print the data in red as long as the upset continued and then in black for every minute for five minutes after the upset ceased.

The time is also determined digitally at the controlling station and is printed on the typewriter at the start of each line of data. The time consumed between requesting data and obtaining a full line of information is approximately 20–30 seconds. A typical example of this type of digital display is shown in Fig. 4.

SPECIAL FEATURES

As aforementioned, the controlling station can request information or a timer can send information automatically. Another device at the "satellite" station can initiate the transmission of operating information. Our "silent dispatcher" is applied to the two measured variables, discharge pressure and flow rate. This monitoring equipment is of the computer type and consists of relays and the commutator with brushes. The transducer for it is the incremental coder (commutator) shown in Fig. 3. Each bar represents 10 barrels per hour (B/H) or 10 psi change in flow or discharge pressure. The computer receives its intelligence from four brushes (two are common) riding on this commutator. Relays count each 2.5 unit change from the previous reading used as a reference point, and with deviations either up-scale or down-scale, this device adds the units of deviation into the counter. The counter adds in units of 10. As the measured variable reverses itself and starts to return toward the reference point, this device subtracts the units of deviation from the counter. Thus, the ordinary small

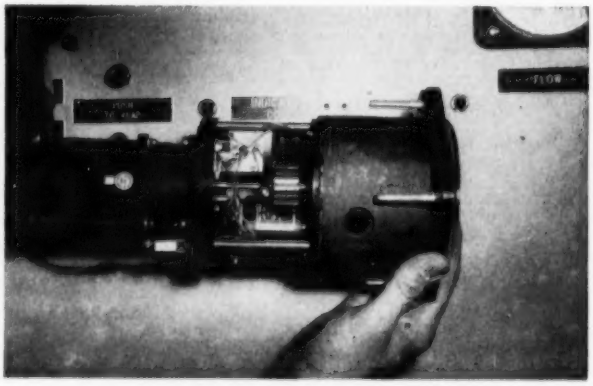

Fig. 3. Telemetering transmitter and encoder.

Table I. Typical Print-Out Record of Relay Station Starting

Deviation Settings	Rate of Change			
Flow 80 B/H Pressure 50 psi	Flow 70 B/H per minute with 40 B/H threshold Pressure 25 psi per minute with 20 psi threshold			
	S	C	D	F
20:55	610	610	610	1,940
21:10	610	610	610	1,940
21:25	610	610	610	1,940
21:40	610	610	610	1,940
21:55	610	610	610	1,950
*22:06	*570*	*940*	*620*	*1,970*
*22:07	*450*	*720*	*680*	*2,180*
22:08	310	670	670	3.0
22:09	250	650	650	2,210
22:10	200	640	640	2,140
22:13	150	630	620	2,050
22:14	150	650	620	1,990
22:15	160	650	610	1,980
22:16	160	650	620	1,980
22:31	160	660	620	1,970
22:47	160	660	620	1,970
23:02	160	660	620	1,960
23:16	160	650	620	1,960
23:31	160	650	620	1,960
23:47	160	650	620	1,960

* These lines are actually printed in red, but are shown here in italics.

fluctuating conditions which are quite natural in pipeline operations never rack up sufficient count to initiate a print-out request. However, when the deviation continues in the same direction and adds up to the given preset amount (adjustable from 40 to 100 psi or B/H) in 10 unit increments, this device recognizes the excessive deviation and sends a complete set of telemetered data to the controlling station. With a reported set of data, a new reference point is established from which new deviations are monitored.

Another part of this computer is a rate-of-change unit consisting of a timing device to sense whether these deviations occur at a slow or fast rate. In batching operations, large amounts of deviation may be expected but the rate will be very slow. However, rapid deviation may result from an "upset" in the system; i.e., such as a line break or a gate change at the receiving point, and should be reported immediately. The alarm signal is adjustable from 1 B/H or 1 psi per minute to 30 B/H or 30 psi per minute rate-of-change. A threshold deviation of 20 B/H or 20 psi must be obtained before the rate of change will cause an alarm. This device initiates the transmission of a complete set of data to the controlling station. The typewriter prints the data in red and an alarm sounds to direct the operator's attention to the upset. Additional printing of data in black is sent in every minute for five minutes after the upset ceases to establish the new operating condition.

A significant point about the "silent dispatcher" concept is that a "key" measured variable is being monitored continuously. The dispatcher at the controlling station can look at the last line of data printed and know that the operating conditions at the "satellite" station have not changed appreciably since the time it was printed, providing the communication circuit is intact. Monitoring of the communication channel is usually a standard feature of supervisory control systems. The need for continuous readings or constant observation on the part of the dispatcher are eliminated.

A deviation type device is necessary in pipeline operations where batching of crudes of different viscosity and variations in flow rates are constantly changing the operating pressures. A pressure switch set to operate close to the normal discharge pressure could approximate the action of the deviation device if, and only if, conditions never changed. Most pipeline operations are certainly not as constant as this ideal.

FUTURE SYSTEM APPLICATION

The techniques discussed in the foregoing paragraphs represent a solution to many of the monitoring problems connected with single or multiple pipeline operation involving a number of "satellite" stations where batching of crudes is practiced, and where varying rates of flow are encountered. The principles discussed in this paper are being applied to other multiple station remote operation on Service Pipe Line Company's system. When the number of variables to be used in pipeline monitoring reach 12 to 60, the transmission of this much data and the method of displaying the information for dispatching use is quite a problem. The digital type display shown in Fig. 4 is most easily assimilated by the dispatcher and certainly makes his task much easier.

On systems involving multiple stations, a teletype code output also is provided at the controlling station to permit retransmission of the data to a central point and can be used in programing into a computer when desired.

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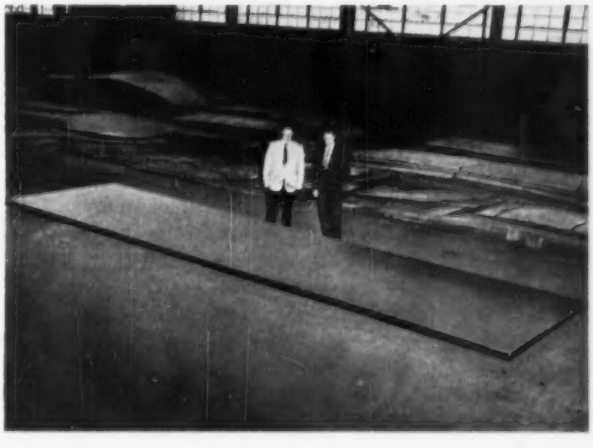
Steel for Atomic Power Station



Stainless steel plate, 84 inches wide, 340 inches long, 3⅛ inches thick and weighing 25,275 pounds, was recently shipped to the Shippingport Atomic Power Station. There it will be formed into a cylinder that will enclose the internal parts of the reactor. Plate was produced by the Allegheny Ludlum Steel Corporation.

Field Treatment in Electric Shock Cases

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W. R. MILNOR

Electric shocks of the order of 0.1 ampere can throw the heart into a twitching state of ventricular fibrillation. Several amperes, on the other hand, simply contract the heart and paralyze the breathing which artificial respiration can relieve. Ventricular fibrillation, however, can be ended only by sending sufficient current through the heart by electrodes on the skin of the chest.

THE TREATMENT of men who are unconscious and not breathing or whose hearts are not beating as a result of contact with an electric circuit is discussed. A study of the accident reports of the Accident Prevention Committee of the Edison Electric Institute shows these symptoms occur frequently in electric shock cases. Two of the major causes of unconsciousness are a temporary paralysis of the respiration or ventricular fibrillation of the heart. When the respiration only is affected, the heart will continue to beat for a few minutes and the pulse may sometimes be detected. In fibrillation cases, the circulation of the blood ceases and there is no pulse. The victim, however, may continue to gasp for breath for a short time.

When an individual is rendered unconscious by a shock and is not breathing, artificial respiration should be started as soon as possible and continued until the victim either recovers or rigor mortis sets in. Table I is a record of 68 artificial respiration electric shock cases taken from the 1955 records of the electric utility companies. This data confirms the findings of Wills Maclachlan[1] that the chances of successful resuscitation become better as the voltage increases.

The injury resulting from contact with an electric circuit, for a given pathway through the body, and duration of contact, depends almost entirely upon the current. In electrical accidents the most common points of contact are the hands and the feet. In this case, both the lungs and the heart, and the nerves leading to them, are traversed by the current. The current that flows is determined by Ohm's Law, but the resistance is rarely if ever known. Therefore, in order to study the effects of shocks on the respiratory and circulatory systems when the duration of the contact is approximately one second, the possible currents through the trunk have been grouped into three rather broad ranges or classes.

Class I Currents. Currents ranging from a few milliamperes up to about 50 milliamperes usually will have no serious results, although they may be very painful and may result in temporary loss of consciousness even though the heart and lungs continue to function.

Class II Currents. Currents ranging between 0.1 and 2 or 3 amperes will destroy the rhythm of the heart, and throw it into a twitching state known as ventricular fibrillation. In this condition, the circulation of blood ceases. The victim may continue to gasp for breath for about a minute, after which the respirations will also stop because the brain is not receiving oxygenated blood. The respiratory center and nerves are apparently not directly affected by the shock, but only indirectly through anoxia. The human heart rarely recovers spontaneously from ventricular fibrillation.

Class III Currents. Large currents of six or more amperes will hold the heart contracted as long as the current is flowing. The blood pressure may fall to very low levels, but when the circuit is broken the heart generally resumes normal beating and re-establishes the circulation. Currents of this magnitude often temporarily paralyze the respiratory nerves or centers and the breathing will cease. Currents of this magnitude may cause serious burns, if the areas of contact with the circuit are small.

BODY RESISTANCE

THE RESISTANCE that the human body offers to the flow of electricity depends, to a large extent, upon the areas of the contacts with the circuit and the condition of the skin. The resistance of the current path from the hands to the feet usually ranges from about 1,000 ohms to several thousand. It is evident, by applying Ohm's Law, that Class II Currents are most likely to be produced by 110- to 480-volt contacts, to a lesser extent by 2,000- to 3,000-volt contacts, and rarely by 6,000- to 8,000-volt circuits. In estimating the current that will pass through the victim, the resistance offered by the external circuit must also be taken into account.

EFFECTS ON HEART AND LUNGS

IT IS WELL KNOWN that the medulla oblongata, or lowest portion of the brain stem, and nerves leading therefrom, control the heart and the lungs. The question which naturally arises is why is it that a current which paralyzes the respiration does not also paralyze the heart? The biological answer is that the heart does not depend upon the brain for its signal to beat, but has centers of its own. The two principal "pacemakers" of the heart are the sinoatrial node and the atrioventricular node, and either of these is capable of driving the heart without a

Essentially full text of paper 57-35, recommended by the AIEE Committee on Safety and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N.Y., Jan. 21-25, 1957.

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The authors wish to acknowledge the financial support of the Edison Electric Institute, and the co-operation of the Johns Hopkins Hospital and the staff of the Hopkins Medical School, in carrying out this investigation.

Table I. Electric Shock Artificial Respiration Cases

Circuit Voltage	Number of Cases	Number Resuscitated	Number of Failures	Percentage Saved
110-480	12	1	11	8
2,000-3,000	34	9	25	26
6,000-8,000	22	8	14	36

signal from the brain. The lungs, on the other hand, will not function unless orders are received from the brain.

The electric shock victims receiving Class II and Class III currents will be unconscious and usually not breathing by the time another member of the line crew reaches them to start manual artificial respiration, the only means of resuscitation available today. Start artificial respiration at once; there is no time to waste in checking the pulse. If the heart is in fibrillation the case is practically hopeless, as only about one human heart in a hundred recovers spontaneously from this condition. If, however, the heart is still feebly beating there is a good chance of saving your man. A study of the accident records of the failures to resuscitate the shock victims (Table I), even though artificial respiration was started with a minimum of delay (Table II), indicates that the probable cause of death in a number of cases listed was ventricular fibrillation.

TREATMENT OF RESPIRATORY FAILURE

THE VARIOUS METHODS of artificial respiration such as the Schafer, Back Pressure Arm Lift, Pole Top method, and others, if correctly applied, provide ample ventilation of the lungs to meet the needs of men whose respiration has been interrupted by an electric shock. These methods are the only ones available today for use in the field, and utility men are well trained in their application. They will often give nature the opportunity to overcome the temporary paralysis and re-establish natural breathing. They are not, however, effective in producing circulation of the blood, or in restoring normal heart rhythm.

TREATMENT OF VENTRICULAR FIBRILLATION

THE ONLY SURE WAY of stopping ventricular fibrillation is to send sufficient electric current through the heart to contract it and bring its twitching muscle fibers to rest. Then, when the circuit is opened, the heart will usually resume normal beating provided the duration of the fibrillation has not been such as to enfeeble the heart. Adrenalin[2] should never be injected into the fibrillating heart.

Table II. Closed Chest Electric Defibrillation Using Hand Electrodes

Duration of Fibrillation Minutes	Number of Animals			Percentage	
	Total	Defibrillated First Attempt	Surviving	Defibrillated First Attempt	Surviving
0.5	85	79	84	93	99
1.	63	59	56	94	89
1.5	62	52	24	84	39
2.	27	25	8	93	30
2.5	2	2	1	100	50
3.	4	4	1	100	25
4.	1	0	0	0	0
5.	4	1	0	25	0

Kouwenhoven and Milnor[3] in their presentation "Electric Defibrillation," at the 1954 AIEE Winter General Meeting, discussed the use of capacitor discharges, a series of short 60-cycle pulses called "serial defibrillation" and a-c applications of 1/4 to 1/2 second duration for arresting fibrillation. Two current paths through the heart, transverse and longitudinal were studied. In the transverse direction, the electrodes were placed on the right and left sides of the chest. The longitudinal path through the heart was obtained by placing one electrode on the sternal notch at the neck and the other on the floating ribs at the apex of the heart.

In all of these experiments the electrodes were placed on the surface of the skin and were coated with cardiograph jelly to insure good contact. The transverse electrodes were held in place on the opposite sides of the chest by rubber bands. The longitudinal path electrodes were mounted on handles and called hand electrodes. The voltage required to drive the defibrillating current through the body was 480 volts. The best results were obtained with the hand electrodes and a single application of the defibrillating current.

In the 1954 paper[3] the authors reported the results of 58 experiments conducted with the 5 x 5 inch hand electrodes. They continued their studies using dogs as the experimental animal. Morphine and ether were used as the anaesthesia. Before inducing fibrillation by means of a 110-volt shock, care was exercised to have the animals under a constant depth of anaesthesia. The dogs ranged in weight from 6 to 17 kilograms. During the period of fibrillation the animals received straight air in their lungs. To terminate the fibrillation, the defibrillating shock was given. During the experiments, the size of the hand electrodes was reduced from the 5 x 5 inch size to a circular electrode of 9 square inches area, and the duration of the defibrillating shock from one second or more to a fraction of a second. Still smaller electrodes may be used, but their application requires higher voltages and increases the chance of burning the skin at the contacts.

The results of 248 defibrillating experiments, including the 58 from the 1954 paper[3], are given in Table II. An electrocardiograph was used to check the condition of the heart, and in most experiments the blood pressure was also recorded. In some of the tests the duration of the defibrillating current application was controlled by hand, the time being measured by a cycle counter; in others a clock-driven timer operating a relay controlled the duration.

In 222 of the 248 experiments the heart was defibrillated by the initial application of the defibrillating current. If this failed, as shown either by the absence of the pulse or by the electrocardiograph record, a second application was given 20 or 30 seconds later. In five experiments three or more applications were required. In only one experiment fibrillation could not be terminated.

No difficulty was experienced in stopping the fibrillation in hearts that had been left in this condition for as long as 9 to 14 minutes. In these cases, however, the heart was apparently unable to resume a normal beat after the fibrillation had been stopped, and the animals died.

In the early experiments, the defibrillation circuit was held closed for almost one second for a heart that had been left in fibrillation for one minute. Although the heart was successfully defibrillated, the experiment sometimes left it in an injured condition in which the auricles and ventricles were not operating normally. Physiologically this condition is known as bundle branch block. If the block was not too severe, these animals would usually recover. Further experiments have also proved that a ¼ to ½ second application of the defibrillating current is sufficient and that under this condition the heart is not injured.

In the last 19 successful hand electrode defibrillations where complete data is available, the defibrillating current ranged from 3.5 to 6.7 amperes, the average being 5.1, and the duration of its flow from 16 to 48 cycles, the average being 24 cycles or 0.4 seconds. The nominal open-circuit voltage of the 25-kva transformer used was 480 volts. The time that the heart remained in fibrillation ranged from ½ to 1½ minutes.

HAZARD

Since electrocardiographs are not available in the field and the pulse may not be perceptible, what would happen if the defibrillating current were sent through the chest of a man who had fainted, and whose heart was beating? Experiments were carried out on 43 dogs whose hearts were beating normally. In no instance did the application of the defibrillating current result in any injury. A number of these animals were kept alive and apparently remained in good health for periods from one week to two months before being sacrificed and subjected to autopsy. No gross evidence of any trauma was found.

In addition, 42 animals were subjected to multiple defibrillations using the hand electrodes. Of these, 12 were defibrillated twice and the others from three to nine times. A number of the animals were kept alive for two months or more and then subjected to autopsy. Again no evidence of trauma was found.

Although no evidence has been found of any permanent trauma resulting from the passage of the defibrillating current through the chests and hearts of 85 animals, this does not signify that the method is absolutely safe to apply to man.

DEFIBRILLATIONS IN HOSPITALS

Ventricular fibrillation also occurs occasionally in hospitals during anaesthesia. According to the best data we have been able to collect, the closed chest method (the electrodes on the surface of the chest) has been successfully used in hospitals to defibrillate the hearts of five human beings, one of whom was a man 80 years old[4] suffering from a heart ailment.

The authors are convinced that the closed chest method of defibrillation is safe and practical, and apparatus for this purpose is being placed at the disposal of the surgical staff of the Johns Hopkins Hospital for use in the operating room. The power supply will be 480 volts as resistance measurements made on the bodies of fresh cadavers have given values ranging from 67 to 90 ohms for the longitudinal current pathway through the chest.

Table III. Delayed Artificial Respiration Effect Analysis

Minutes Elapsed Time before Starting Artificial Respiration	Number of Cases	Successful Number	Percentage of Resuscitations
2,000 to 3,000 Volts			
½	17	7	41
1	6	1	17
2	2	1	50
3+	6	0	0
Unknown	2	0	0
6000 to 8,000 Volts			
½	11	6	55
1	2	1	50
2	2	1	50
3+	6	0	0
Unknown	1	0	0

PROMPTNESS

It has been stated that artificial respiration should be applied promptly to save a victim of electric shock, and the same holds true for closed chest defibrillation, if the heart is to resume normal beating. Table II shows that if you can apply the defibrillating shock within one minute or less the chances of success are better than 90 per cent.

A similar analysis of the effect of the delay in starting artificial respiration is presented in Table III. This is an analysis of the 2,000- to 3,000-volt and 6,000- to 8,000-volt artificial respiration cases of Table I and is based on the effect that the elapsed time, before manual resuscitation was started, has on the result.

It is clear from the data presented in Table III, that promptness in starting manual artificial respiration in electric shock cases is equally as important as promptness in defibrillating the heart.

The impossibility of starting artificial respiration at once, because of circumstances beyond the control of the rescuer, is another reason for some of the failures listed in Table I. Severe burns also accounted for others.

It must be kept in mind that Table III lists only a relatively small number of electric shock cases, and that shock victims have been saved when the starting of manual artificial respiration was delayed. Therefore if you are late in starting, *start*. You may save a life that would otherwise be lost.

FIELD EQUIPMENT

With the co-operation of Dr. Paul Betz,[5] of the Baltimore Gas and Electric Company, we are working on the development of defibrillating equipment for use in the field.

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The Mountain Sheep – Pleasant Valley Project

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THE MOUNTAIN SHEEP-PLEASANT VALLEY PROJECT is located in the rugged, mountainous section of the Snake River, immediately downstream from the Idaho Power Company's Hell's Canyon site. The ultimate development will add 1,446 megawatts to the Northwest Power Pool which faces a possible shortage of power after 1960. The Pleasant Valley power plant (see Fig. 1) would have the third highest true-arch dam in the world, 534 feet, and would have generator units with a capability of 170,000 kilovolts each, larger than any present hydroelectric units. Application to build the two power plants was filed with the Federal Power Commission on September 7, 1955, by the Pacific Northwest Power Company.

Because of the remoteness of the project, the development of a transmission system to meet all the complex requirements of economy of design, integration with the Northwest Power Pool, and co-ordination of the plants of the organizing companies, called for unusual exploration and study.

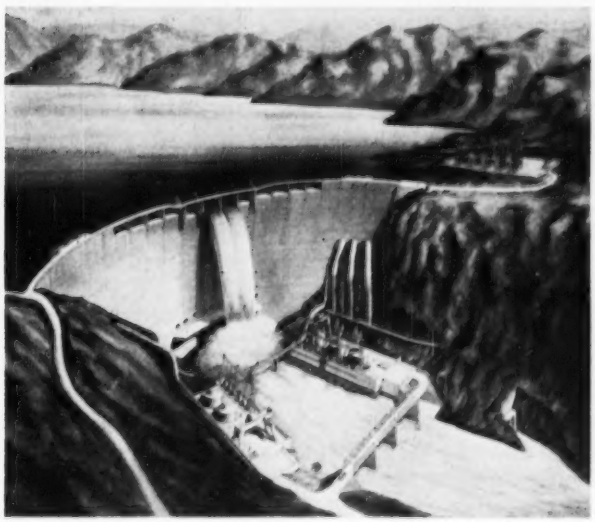


Fig. 1. Artist's conception of proposed Pleasant Valley power plant.

A Northwest Power Pool load level of 25,000 megawatts (3½ times the January 1955 peak) was selected for the first studies to develop the pattern of the ultimate transmission system. The need for transmission should be a maximum at this load level, which corresponds to the output of about all of the feasible large hydroelectric projects. The purpose of this study was to avoid having transmission lines built for initial load requirements which would not carry appreciable load in the future interconnected network. Intermediate load levels of

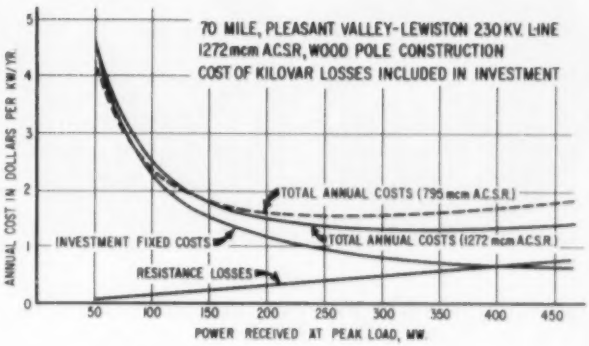


Fig. 2. Typical transmission line cost curve.

15,000 and 13,000 megawatts were chosen, having widely divergent resource location assumptions to test the proposed transmission lines.

Despite the large capacity of the project, 230 kilovolts was found to be lower in total annual costs than 345 kilovolts for 700 miles of the proposed transmission lines, inasmuch as the power is transmitted in four different directions: south to Hell's Canyon; east to Anaconda, Mont.; north to Spokane, Wash.; and west to Walla Walla, Wash., and Portland, Ore. Although as much as 1,200 megawatts would flow in a single direction from the plants to a major switching station at Lewiston, Idaho, the distance is 70 miles or less, so the higher voltage equipment costs outweigh the savings in transmission at 345 kilovolts. Only the 300-mile Lewiston–Portland line was justified at 345 kilovolts, and bundle conductors were found to be lower in initial cost for this steel-structure line than single large conductors with the equivalent series capacitor compensation.

Most of the 230-kilovolt lines are of wood-pole construction except in steep mountainous areas or in the Snake River Canyon. About 270 miles of 230-kilovolt line would utilize 795 MCM ACSR (aluminum cable, steel reinforced) conductor, while the remainder would be of 1,272 MCM size, either, ACSR or all-aluminum, depending upon whether or not a line section would be of wood-pole short-span design, where less costly aluminum conductor is applicable. It is shown in Fig. 2 that the economic loading curves for 230-kilovolt wood-pole lines are relatively flat above 150-200 megavolt-ampere peak loading, with 1,272 MCM ACSR more economical than 795 MCM ACSR above 150 megavolt-amperes.

Digest of paper 56-709, "Transmission Planning for Mountain Sheep-Pleasant Valley Project," recommended by the AIEE Committee on Transmission and Distribution and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Summer and Pacific General Meeting, San Francisco, Calif., June 25-29, 1956. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1956.

W. A. Morgan, G. R. George, R. C. Guse, and M. F. Hatch are with The Washington Water Power Company, Spokane, Wash.

Comfort A. Adams 1956 Edison Medalist

" . . . for pioneering achievements . . . for vision and initiative . . . and for eminence as an educator and consulting engineer."

Medal History

E. P. YERKES
FELLOW AIEE

THE EDISON MEDAL presented today is the 46th in the series. The Medal is awarded annually ". . . for meritorious achievement in electrical science or electrical engineering or the electrical arts." The award traditionally has consisted of three articles. The first item is a gold medal which is valuable enough, and we hope cherished enough, so that it is kept in a bank vault, seldom seen by the owner and never seen by others.The second one is a full-size bronze replica of the Medal which is useful as a paperweight. It is therefore likely to be found on the Medalist's desk in company with assorted bits of glass and various advertising gimmicks used for the same purpose, so that it is seldom noticed by anyone. Of course, if the Medalist is a perfect executive, nothing ever appears on his desk except a set of 12 push buttons, so that the bronze medal replica is never seen. The third article traditionally awarded is a certificate. This is sometimes filed away with the Medalist's other papers and forever lost to view. In other cases it is framed and hung on the owner's office wall but, if so, it is hung behind him so that it is visible to visitors but rarely to himself.

This year, in place of the full-size bronge replica, the Committee decided to include another article in the award, which the Medalist can keep constantly with him, to remind him of the honor which he has received. It is a small gold disk, with a replica of the obverse of the Medal on one side and an appropriate inscription on the other. This, it is hoped, will personalize the award somewhat more than has been the case previously.

The 1956 Medalist was chosen by the usual process. The Committee received proposals from various sources, including seven carried over from its deliberations of last year, and after free discussion and careful consideration, chose one of the number by secret ballot. This choice was later confirmed by polling the entire Committee membership by letter ballots. The award this year is conferred upon Dr. Comfort Avery Adams.

The culmination of the Committee's work as portrayed in this ceremony is a very agreeable event, but the preliminary work, that which preceded the final selection, was most difficult. It is both pleasant and fairly easy to discover men whose achievements qualify them for the Edison Medal, but to search out and choose one among them supremely qualified is a very difficult and baffling assignment. The Committee is proud, and justly proud, of its work, and the present Medalist, one of the rapidly shrinking band of Thomas Alva Edison contemporaries, in joining the distinguished list of former Edison Medalists, confers still further distinction upon that group.

The Medalist

R. J. WISEMAN
FELLOW AIEE

THE CITATION for the award of the Edison Medal to Comfort Avery Adams reads: ". . . for pioneering achievements in the development of a-c electric machinery and in electric welding; for vision and initiative in the formation of an engineering standards organization; and for eminence as an educator and consulting engineer."

This summarizes a life of 65 years in the field of education and engineering. Comfort Avery Adams started his life in Cleveland, Ohio, on November 1, 1868, 88 years ago. He obtained his college education at the Case School of Applied Science, now known as Case Institute of Technology, from which he graduated in 1890 as a Bachelor of Science in Mechanical Engineering. At that time electrical engineering as a profession was still in its swad-

Presentation and acceptance addresses at the Edison Medal ceremonies held during the AIEE Winter General Meeting, New York, N. Y., January 21-25, 1957.

E. P. Yerkes is engineer of equipment, eastern area, Bell Telephone Company of Pennsylvania, Philadelphia, Pa.

R. J. Wiseman is vice-president and chief engineer, The Okonite Company, Passaic, N. J.

dling clothes and yet to win respect as a major field of engineering. In fact, we might consider our Medalist as a pioneer in this phase of engineering. In 1891, he started his long teaching career at Harvard University, a career that covered 45 years when he retired in 1936. During those fruitful years he served successively as instructor, assistant professor, and professor of electrical engineering. His present title is Lawrence Professor of Engineering and Gordon McKaye Professor of Electrical Engineering, emeritus. For a short time he also acted as Dean of the Harvard Engineering School.

In the early 1900's, Dr. Adams was already engaged in writing about "alternator regulation, synchronous motors, and induction motors," magnetomotive-force circle diagrams, wave shape of alternators, paralleling of generators, high-frequency induction motors, and repulsion motors. His knowledge of electromagnetics soon drew him into the induction-furnace field, which led to the design of high-frequency induction furnaces and later 60-cycle furnaces.

Electric welding has been one of his outstanding areas of interest. During World War I, he served as chairman of the welding committee of the Emergency Fleet Corporation which was given the project of applying the welding process to the building of ships. At that time, the welding art was in its infancy and many problems had to be solved—correctly and quickly. The teamwork between the committee and the manufacturers of welding equipment was so effective, that this form of co-operation was perpetuated by the organization of the American Welding Society in 1919 and Professor Adams became its first president, later being elected to honorary membership.

During the period of the rapid growth of welding, it became a major interest to the Boiler Code Committee of the ASME whose rules are accepted as law in most of our industries in the United States. Professor Adams was then taken into the Boiler Code Committee and helped change and expand its rules to cover the welding of boilers and pressure vessels; a method which now is generally employed in place of riveting by the entire industry. At about this time, he organized and was first chairman of the Welding Research Council of the Engineering Foundation, which now has an annual budget of more than a half million dollars. He was a respected and productive consultant for many years to the Babcock & Wilcox Company and to the E. G. Budd Company where his work on electric welding contributed greatly to the successful adaptation of alternating current to welding. After the death of Dr. Steinmetz, he acted as part-time consultant for the General Electric Company dealing with problems inherent in the design of electric machinery.

Standardization has been one of Comfort Adams most satisfying activities. In 1910, he was made chairman of our AIEE Standards Committee and served thereon for about 10 years. Finding considerable overlapping between the standardization work of the several engineering societies, he organized and was first chairman of the American Engineering Standards Committee in 1918 and which in 1920 became the present American Standards Association covering all industrial standards.

COMFORT AVERY ADAMS *(center right)* **receives the Edison Medal from AIEE President Mervin S. Coover** *(center left)* **at the Winter General Meeting, January 21, 1957, in the Hotel Statler, New York, N. Y. Dr. R. J. Wiseman** *(left)* **and E. P. Yerkes** *(right)* **look on.**

At the thirty-fifth anniversary of that pioneering committee Mr. A. E. Gay, the then chairman of the ASA said:

> "As its first act at that first meeting, the committee elected a very distinguished gentleman as its chairman. He was Dr. Comfort A. Adams of the Harvard Engineering School, president of the AIEE and member of the ASME. The standards movement of this country owes an infinite and unrepayable debt of gratitude to Professor Adams for his wise and patient leadership during the founding years of the national movement."

During his chairmanship of the Engineering Division of the National Research Council in 1919-1921, Dr. Adams was instrumental in setting up a "Conference on Electrical Insulation" to meet the need of research and co-operation in the field of dielectrics, which was becoming very important because of the advances in the other fields of the electrical art. This conference, held annually, is one of the outstanding examples of what can be accomplished through co-operation.

At the Golden Jubilee of the International Electrotechnical Commission held in Philadelphia, Pa., in September 1954, special honor was accorded Dr. Adams as one of the pioneers in the founding of the IEC 50 years earlier, on which occasion he presented an important paper on a new element in "The Leakage Reactance of Induction Motors."

Although the principal efforts of Dr. Adams have been concentrated on electric machinery and welding, he has also been interested in electric cables. In the 1900's, voltage testing of cables resulted in failures that were difficult to explain. His study of the problem indicated that it was due to the poor wave form of the power supply. As a result, he designed a sine-wave generator to overcome the difficulty. Thus, today we find specifications limiting the

departure of the voltage wave from a sine-wave shape. He has served as a consulting engineer for The Okonite Company on electric cables from 1909 to 1955. Not only has he helped solve many problems, particularly on high voltage cables, but also he has provided company engineers with a course in dielectrics and cable testing, which is not available at any college.

During his professional career, Dr. Adams has been a sort of trouble shooter in his consulting capacity. He became an expert on the causes of gas and dust explosions. He introduced features in the design of machinery in the sugar refining and cotton nitrating fields that were revolutionary and solved major production problems.

Perhaps his greatest accomplishment, and one in which he takes justificable pride, is his ability to impart to others his views on a particular subject, whether he is acting in the capacity of a teacher or as a consultant. His method of approach is well worth reviewing. When discussing the standards and principles which guided him, he stated that he

> ". . . early discovered that the validity of any logical deduction depends quite as much upon the soundness and comprehensiveness of the premises as upon the rigidity of the logic employed.
>
> "This principle indicates at least two important phases of education:
>
> "First, the training of the mind in sound and unbiased logic, that is, in the habit of thinking for oneself rather than conformity with prevailing contentions or traditions which are often not only superficial, but also occasionally unsound.
>
> "Second, the recognition of the importance of both accurate and comprehensive premises for each problem. Although in some simple cases, such dependable premises may be taken from a well-stocked memory, it more often happens, particularly in the case of the more difficult and the more important problems, that the search for dependable premises may involve a lot of work and study as well as a lot of time. Moreover, it is often impossible to state the comprehensive premises clearly without a sound quantitative perspective of the phenomena involved."

We, who have been associated with Dr. Adams as students and as clients, can vouch for this philosophy of education. As a teacher, he always would develop the particularly problem, step by step, from its fundamentals, and finally reach the solution with the application clearly shown. When attacking a problem as a consultant, he has always required all of the facts of the case as then known; asked questions to help clear the air; proceeded to identify what is known and what is unknown; suggested methods of attack involving, many times, researches or reviews of past practice; and finally applied a solution.

Two episodes related to me by his own students reveal the human aspects of this man's thinking. One of his former students mentioned the professor's famed two-hour lectures which were always interrupted by a recess. I do not intend to imply, however, that even such an inventor as Dr. Adams was the father of today's "coffee break." My friend did say that, at the end of the interval the class would always watch the professor with fascinated eagerness to see how long it might take before a wisp of smoke would rise out of his pocket from a hastily concealed pipe. Yet, no one who has ever been in session with Comfort Adams will admit that his forthright thinking has ever been concealed behind a smoke screen.

The other student, sitting in the back of the room one Spring day listening to Professor Adams lecture on induction motors, thought the subject being presented was too simple to require his attention. He allowed his mind to wander. Later, when endeavoring to reconstruct the theory, he found it was not so simple and decided that it was the lecturer rather than the subject that was easy to understand.

The most recent case of his capabilities occurred at the AIEE Winter meeting last year when he presented a paper dealing with zero-phase sequence impedance of a high voltage pipe type cable system. The presence of the magnetic steel pipe introduces a ferromagnetic problem and the usual formulas do not apply. The problem was explained to Dr. Adams. Tests were conducted by many manufacturers and utilities which accumulated data for reference purposes. Applying to these facts the knowledge he had acquired over the many years of studying electromagnetic phenomena, Dr. Adams presented a paper a year ago entitled: "The Penetration of Electromagnetic Radiation into Ferromagnetic Materials." Since its publication, we have had the opportunity of checking his approach over a wide range of currents by actual tests and are happy to say that both agree remarkably well. The paper should be considered as a classic and I personally am delighted with the title which he has given to it. It takes us back 50 years when it was the custom to have titles for papers which provided two reactions – either they aroused your curiosity to read or else frightened you away forever. Happily this title has aroused the curiosity and interest of those associated with the electric cable industry.

A list of some of the honors already received by our medalist follows:

Two honorary degrees of Doctor of Engineering
Oldest living past president of AIEE
Lamme Medalist of AIEE
First president and oldest living past president of the American Welding Society
Honorary member of the American Welding Society
Delivered the first of the series of Adams Lectures founded in his honor by the American Welding Society
Organizer and first chairman of the Welding Research Council, now honorary chairman

First Recipient of the Samuel Wylie Miller Medal of the American Welding Society

Honorary member of the Board of Directors of the American Welding Society

Longtime member of the Boiler and Pressure Vessel Committee of ASME, now honorary member

Honorary member of the International Acetelyne Association

One of 35 engineering members of the National Academy of Sciences. This is equivalent to a British Fellow of the Royal Society (FRS)

When we review Dr. Adams' accomplishments, I believe you will agree that Philip Alger best expressed it when Dr. Adams was presented with the Lamme Medal. I am taking the liberty of quoting his remarks:

> "Looked at in retrospect, his distinguished career is seen to have resulted naturally from his pre-eminence in the old-fashioned virtues of clear thinking, persistence, and absolute reliability. He has devoted his life to the advancement of engineering by unselfish aid to students and fellow engineers as well as by his own inventions. In so doing, Dr. Adams has earned a lasting place in the Hall of Fame of American Engineers, and he has also made a host of friends who will ever value the inspiration he has given them."

These words were originally spoken in 1940. Except for the emphasis added by 16 subsequent years of continued high performance, they remain equaly true today. It gives all of us great pride to honor Comfort Avery Adams as dean of AIEE.

Education

C. A. ADAMS
FELLOW AIEE

FIRST, I wish to express my deep appreciation for the high honor bestowed upon me by the Institute and its Edison Medal Committee.

I also wish to thank Dr. Wiseman for his generous presentation.

Of the numerous fields of all my professional activities the most important one, in my estimation, is that of *Education* which after all is the most important factor in the evolution of civilization. It is on this account that I have taken that title for this address.

Looking back on my own education I realize how fortunate I was in having some wonderful teachers to whom I owe much of my success in later life. Of my formal teachers I will mention only a few. First and most important, Newton M. Anderson, teacher of Physics in the Cleveland Central High School, the best teacher of my whole experience, who definitely determined the direction of my future activities. It was through him that I obtained not only a scholarship in Case School, but also a job as laboratory assistant to Dr. A. A. Michelson, one of the greatest physicists of this country. In my freshman year at Case, I participated in the construction of the large interferometer employed in the Michelson-Morley experiments on ether drift, the result of which was one of the foundation stones of the Einstein Theory.

During my 45 years at Harvard, I was intimately associated with a group of great men and teachers not only in the field of science and mathematics but also with such men as President Elliot, William James the great psychologist, Josiah Royce the great philosopher, and Frank Tausig the head of the Federal Tariff Commission. Throughout my professional career, one of my greatest teachers was Dr. Steinmetz.

I come now to a phase of the important problem of Education which has no direct relation to the fitness of this award, but has much to do with the success of our great democracy; namely, the critical shortage of properly trained engineers and scientists. The evidence of this shortage is so abundant that it needs no repetition before this audience. But how can it be corrected?

First a few statistics from an article by Phillip Sporn in *Electrical Engineering*, September 1956. Of the 2.5 million boys and girls of college age in this country, only 11.5% get first college degrees, and only 1.5% get first degrees in engineering and the sciences (for 1955).

However, since hereafter we shall be dealing with the broad problem of education, we shall assume that the 11.5% or about 1/9 of our total youth gets a first college degree and that this includes practically all of those who continue on into either professional or public life. In other words, the large majority of the most important element in our society is selected from the 1/9 of the total.

As engineers, we go to great lengths in research to find the best materials for various types of structures, particularly those new ones demanding unusual properties.

Is this not in striking contrast to our method of dealing with the most important of all raw materials—the human mind—the development of which is what we call education?

After many years of teaching and even more years of contact with industrial personnel, I am convinced that the average brain power of the 8/9 group is more than half of that of the 1/9 group and that the number of brilliant minds in the larger group is more than that in the smaller group. In other words, our dependence on the smaller group constitutes a serious and unnecessary limitation.

In contemplating this problem more than 50 years ago, I had what I called a "Pipe Dream," stimulated in part by the operation of two of our Federal establishments, West Point and Annapolis, where the students once selected are provided not only with education but also food, lodging, and clothing. Thus, the Government was evidentally convinced that no financial consideration

C. A. Adams (retired) is Lawrence Professor of Engineering and Gordon McKaye Professor of Electrical Engineering, emeritus, Harvard University.

should intervene in the case of the education of the officers for the U. S. Army and the U. S. Navy.

Is it not quite as important to have an equally well-educated pool from which to draw the officers and staff of our great industrial and economic institutions? In fact, the present critical shortages in this pool is the best evidence of this need, because it is unquestionably due to its restriction to the 1/9 group.

Before presenting my "Pipe Dream" it is only fair to state that it was also presented in a slightly different form in the Fifteenth Steinmetz Memorial Lecture which I delivered in Schenectady about 15 years ago. Unfortunately, it was printed only in pamphlet form and has long since been exhausted.

With this introduction, my "Pipe Dream" briefly, is as follows:

1. Every child to be given a general elementary education up to about the tenth grade which is half way through high school. About 80% of our youth accept this free education under our present system and no significant change is proposed in that zone, above which the drop-out increases rapidly.

2. At the end of this period with the aid of the best available aptitude tests and other examinations, a weeding-out process will take place and only those with reasonably good promise will pass on to the second stage during which they will not only get free education, but also a modest financial support to cover their other living expenses when this is needed. On this basis, it may be assumed that a larger percentage of the whole will be promoted than under the present conditions.

3. At the end of this second stage and with the aid of the various tests, there will be a second weeding-out process which will involve considerable segregation and leave only those who give promise of excellence in one of the several fields of activity including science, engineering, literature, history, languages, law, medicine, economics, Government, and business administration.

4. At the end of this third stage, there will be a final weeding-out leaving only those who have shown enough promise to warrant advanced work in their chosen fields leading to higher degrees.

Except for the first stage, students will be provided not only with free education, but also with a modest allowance for living expenses for those who actually need it. Without this latter feature, the objective of this plan could not be reached, namely the utilization of 100% of our total native ability.

A more careful study of this plan will show that its successful development would be slow, even with the necessary legislation, and that it would require some fundamental changes in our entire educational setup, including much more emphasis on the standards for teachers as well as higher salaries, particularly for those in the elementary public schools. Moreover, inasmuch as the problem now facing us is very real and acute, and because the proposed plan seems to be the only one in sight which makes possible utilization of substantially the entire pool of native brain power in all fields, it is certainly worth consideration.

With this plan in full operation the following trends would naturally obtain;

1. Much more competition in the more interesting professional or highly specialized occupations, and much less in those requiring more brawn than brain.

2. A tendency to reduce the difference in remuneration as between these two general groups. Moreover, with the advance of mechanization of industry, the percentage of those in the now favored groups would undoubtedly be increased largely as compared with those in the unskilled labor group. The need for this change is vigorously demonstrated by the present shortage.

3. A very great increase in national efficiency. Of this I am firmly convinced, after many years of thoughtful consideration of these problems, coupled with a very unusual opportunity for observation of the industrial machinery and personnel of the United States.

4. A considerable raising of the general level of intelligence, which would apply to practically all occupations.

5. Finally it would bring us much closer to our ideal of equal opportunity for all.

Since there will doubtless be many who object to this addition to the socialistic feature of our public schools, I am presenting only a few of the major socialistic features of our present economy.

1. Our entire system of free education through the high school and to a lesser degree through our State Universities
2. The Post Office Department
3. All of our public roads and bridges, even those requiring special tolls
4. Public water works in most of our large cities
5. Sewage disposal systems in practically all of our cities
6. All Government departments headed by Secretaries in the President's Cabinet
7. More recently, the Social Security and Welfare Acts
8. Thousands of successful co-operatives

Although this plan would require some addition to the total Government budget, State and Federal, or both, it is altogether probable that this would be balanced by the resulting savings due to the higher efficiency of our industrial, economic, and social institutions.

Fortunately we are not entirely without experience in the operation of this plan, because the "G.I. Bill of Rights," for World War II veterans, provided the same opportunity but only for veterans, most of whom would otherwise have been in the 8/9 group and who surprised everybody by their ability to take advantage of their wartime educational opportunities.

Although some little Government assistance is still given to veterans, the big gap and the resulting shortage still remains, not only in science and engineering, but also in all other occupations which so sadly need a higher or broader education.

A Data Transmission Machine

C. R. DOTY
ASSOCIATE MEMBER AIEE

L. A. TATE
ASSOCIATE MEMBER AIEE

MODERN BUSINESS OPERATIONS have developed a requirement for rapid and accurate communications, involving the exchange of engineering, scientific, statistical, and accounting data. The points between which communication is required may be within the same building or they may be separated by hundreds of miles.

The requirements for a communication system for transmitting data are substantially different from the requirements for transmitting message traffic. The fundamental difference lies in the degree of accuracy required. In message traffic, the inherent redundancy of English text permits "reading through" an occasional error. By comparison, the inherent redundancy in data is extremely low, and a single error may cause misinterpretation of the message. For this reason, an error-detecting means must be used in order to insure accurate results.

The IBM (International Business Machines Corporation) Data Transceiver reads and transmits information from punched cards and records the information by punching cards at the receiving location. Transmission may be over telephone or telegraph circuits, using wire lines, radiotelegraph, or microwave facilities. Means for detecting and correcting transmission errors (character mutilation) are included.

The Data Transceiver comprises two units. One unit includes the card reading and punching mechanism (for sending or receiving) and the other unit contains the electronic commutator and circuitry for transmitting and receiving signals. Tone signaling is used for operation over telephone circuits and direct current signaling is used for telegraph circuits. Different signal units are used for the two classes of service. The telephone signal unit also contains equipment for deriving channels so that as many as four transmissions can be accomplished simultaneously over a single telephone circuit. The tone frequencies used are 800, 1,300, 1,800, and 2,300 cycles. The telegraph signal unit will operate at the three most commonly used keying speeds of printers.

The card production on telephone circuits is 11 per channel per minute when all 80 columns are transmitted. On telegraph circuits 3, 4, or 5 cards per minute may be transmitted over 60, 75, or 100 word facilities, respectively. Card production increases if this machine is programmed to transmit less than 80 columns per card.

Pluggable units permit the operators to change from one telephone channel to another, or from one telegraph operating speed to another, so that the machine will match the operating characteristics of the circuit to which it is connected.

The Data Transceiver uses a fixed count error detection signaling code in which each character contains four marking and four spacing elements, enabling the receiver to detect all single errors and all multiple errors except those which compensate each other, to produce no net change in the number of marking and spacing elements in a character. This error-detecting code was chosen on the basis of field-testing experience, to provide the required degree of accuracy with a minimum of redundancy added to the message. These tests were conducted on many types of communications circuits, including transoceanic radio.

In addition to the fixed-count and invalid-code combination checks of each character, the receiving machine performs other checking functions, including a check to see that the correct number of characters is received for each card, and that the machine is not out of cards. Detection of any failure stops both the transmitting and the receiving machines. The receiving machine stops immediately upon the detection of a failure. The transmitter stops at the end of the card being transmitted when the failure occurred. So that the receiving machine can exercise complete control over the transmitting machine, the transmitter is arranged to stop at the end of each card and send a special code combination (end-of-card). If no failure has been detected, the receiver responds by sending an acknowledging signal (start). Reception of this acknowledging signal permits the transmitter to feed the next card and resume transmission. If a failure is detected, and the receiver does not transmit the acknowledging signal, the transmitting machine stops. Both machines must then be restarted by the operators, and the transmission of the card is repeated. In this manner detectable errors and other failures may be corrected immediately, so that each received card is a complete and checked transmission.

The machines operate on a start-stop principle both with respect to the card reading and punching functions and the signaling. Each character is preceded by a "start" or synchronizing pulse and is followed by a "stop" period.

Electronic circuitry permits the use of extremely short samples (50 microseconds) for regenerating the received signals. Thus, distortion of the received signals will not interfere with the proper operation of the machine unless it becomes so severe that it affects the center of a signal pulse.

Field testing and operating experience indicates that an extremely high degree of accuracy is obtained on all types of circuits. The present uses of Data Transceivers and the increasing interest shown by commercial and military planners indicate that Data Transceivers will find a wide field of application in data transmission.

Digest of paper 56-985, recommended by the AIEE Committee on Telegraph Systems and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Fall General Meeting, Chicago, Ill., October 1-5, 1956. Published in AIEE *Communication and Electronics*, November 1956, pp. 609-03.

C. R. Doty and L. A. Tate are with the International Business Machines Corporation, Poughkeepsie, N. Y.

INSTITUTE ACTIVITIES

A Message from the President

Dear Institute Member:

Some of us joined the AIEE a long time ago. Life was simpler in those days. There were not so many organizations to join. We were quite sure that we could use all of the help that any organization could give us in finding a job, in keeping it, and in making professional progress. As the years pass, our judgment is confirmed and our attachment to the organization becomes greater, especially as we contribute more of our time and effort to it. But in this complex world of today, it is apparent that what seems obvious to us is not so obvious to everyone.

The best information available indicates that our AIEE membership includes less than half of the total number of electrical engineers in the United States today. Many members of AIEE are working essentially elbow to elbow with fellow electrical engineers who are not members of our Institute but who can fulfill the qualifications for membership.

The number of young men who have received degrees in electrical engineering from accredited curriculums within the last 12 years exceeds the present corporate membership of the AIEE. They are all eligible for the grade of Associate Member in

AIEE. As new areas in technical developments are opened, they inevitably will be in the hands of young men. As AIEE continues its own professional growth and development, it will need these young men in numbers and the young men will need the AIEE.

If, as members, we believe in our Institute, if we have pride in our profession, if we have faith in our own abilities, if we have a deep-seated burning desire to make personal and professional progress, if we recognize that there are opportunities for wider personal service to our profession from within our Institute where there is teamwork, then surely we will want to help our fellow engineer, regardless of his age, by trying to bring him into our Institute. I invite each of you to make this personal effort. Every one of us knows the procedure; it simply remains for us to act. Once the candidate is elected to membership, let us be certain that he is given opportunity to participate actively in his Section or Subsection.

Permit me to emphasize that it is not numbers that I have uppermost in mind, it is quality of service to our membership and, in turn, to humanity at large that is of prime importance. Size of corporate membership is only the end result if we are to succeed in maintaining our stated principles and objectives. Our degree of success will be determined by our sincerity, by our conviction, and by our individual effort.

Cordially yours,

M S Coover

President, AIEE

Full Technical and Social Program Planned for Southern District Meeting

THE AIEE Southern District Meeting will be held in Jackson, Miss., April 3-5, 1957. The Heidelberg Hotel will serve as headquarters for the meeting and all technical sessions will be held there.

A well-rounded technical program will include many sessions on communications, transmission and distribution, metals and insulated cables, computers, transformers, protective devices, chemical industry, power generation, telemetering, microwave radio systems, and system engineering. The District Student Paper Competition is scheduled during the meeting. Chester McKee is chairman of Student Activities for District 4.

Social Activities

Social activities for the members and their guests are complete in every respect. There will be a hospitality hour, a luncheon, and a dinner dance, and for the ladies there will be a bridge and canasta luncheon, a coffee hour each morning, and a variety of sightseeing trips.

Arrangements are being made to hold over the annual "Natchez Pilgrimage" which officially ends on March 31. Here visitors will see ante-bellum homes which have been restored to their former beauty, graced by their owners dressed in costumes of the period. The guided tour will include highlights of each of the famous homes. This event is nationally known and has been featured on the network television show, "Wide Wide World."

General Session

The meeting will be called to order at 9:30 a.m., Wednesday, April 3, by R. D. Yarbrough, general chairman. Mr. Yarbrough will introduce J. P. Coleman, governor of Mississippi, who will bring a message of welcome. Following this, Mayor A. C. Thompson of Jackson, Miss., will welcome those attending to his delightful city. The major address will be given by J. O. Emmerich, editor of the *McComb Enterprises Journal*.

Inspection Trips

The following interesting inspection trips have been arranged for the members attending.

Mississippi Products Company—This is one of the largest industrial manufacturers in Jackson, employing approximately 1,000 people in the manufacture of sewing machine cabinets, television and radio cabinets, and finished furniture. The plant offers a good opportunity to see interesting detailed work of veneer and panel furniture assembly. One can see the process from the log to the completed furniture.

Rex Brown Steam Electric Station of Mississippi Power & Light Company—This is a 143,000-kw outdoor steam plant, using underground water and cooling towers. A new unit of 230,000 kw is being added in 1959. It is one of three steam stations on this company's system which totals 420,000 kw.

Century Manufacturing Company—This company is a subsidiary of National Presto Industries. The inspection party will have an opportunity to see the manufacturing processes necessary for producing electric and gas appliances. This is a new and modern industry for this area. Approximately 650 people are employed.

Vickers, Inc.—This is a completely air-conditioned manufacturing plant for hydraulic pumps which are used in aircraft. The industry is new in this area and the inspection party can see a completely modern precision manufacturing process. Guided tours in parties of 8 or 10 will be arranged so that specific machine operations can be observed.

Armstrong Cork Company—This plant manufactures resilient floor coverings in 9-inch squares and this inspection tour will prove to be quite interesting. There will be

an opportunity to visit the entire plant on a guided tour so that all phases of cork tile manufacturing can be observed.

Southern Bell Telephone Building—This tour will enable visitors to see local dial equipment, a time announcing service, long distance switchboard, and a television control center, including color monitor. Since two coaxial cables cross in Jackson, this is quite a switching center for television and long-distance service.

Each of these inspection trips is scheduled for late afternoon, after the technical sessions have been adjourned.

Ladies Program

The ladies' headquarters will be in the Heidelberg Hotel. Coffee and doughnuts will be served every morning during the meeting at 9:30 a.m. Hostesses will be on hand at all times to extend a welcome, help visitors get acquainted, and answer any questions. On Thursday, April 4, the ladies will be entertained at a bridge and canasta luncheon from 12 noon to 5 p.m. During the week, cars and guides will be available for tours of local and distant points of interest.

Advance Registration

Please register in advance by returning the advance registration card properly filled out. In so doing, time will be saved in completing registration details upon arrival at the hotel. The registration fee for members will be $3 and for nonmembers $5. Student members and members of families will not be required to pay a fee. Registration facilities will be located in the lobby of the Heidelberg Hotel.

Hotel Reservations

A large number of rooms are available at the Heidelberg Hotel, meeting headquarters, and at the Robert E. Lee, Wilthall, and Edwards Hotel.

Rates are as follows: Single Room—$5 to $8; Double Room—$7 to $11; Twin Bed Suites—$18.

Transportation

Access to Jackson, Miss., can be made by rail, air, or highways. Both the Illinois Central and the Gulf Mobile and Ohio Railroads have regularly scheduled connections into Jackson. The Delta and the Southern Air Lines both have good schedules to the capital city. The best highway connections entering Jackson are U. S. routes 49, 51, and 80.

Committee

Members of the 1957 Southern District Meeting General Committee are: R. D. Yarbrough, chairman; N. L. Stampley, vice-chairman; J. R. Burnie, secretary; and C. A. Rogillio, treasurer. The Advisory Committee includes R. B. Wilson, H. G. Turner, and M. E. Collum; Committee Chairman are: Mrs. J. B. Fountain, Ladies' Committee; R. B. Wilson, Finance; J. L. Maxwell, Technical Program; R. W. Braswell, Publicity; T. M. Salisbury, Printing and Tickets; R. E. Briggs, Registration; F. C. Weems, Hotel Arrangements; J. B. Fountain, Transportation; T. R. Brock, Inspection Trips; Dr. Chester McKee, F. D. Joffrion, Students; and J. G. Gates, Dinner Dance.

The tentative technical program for the District Meeting follows.

Wednesday, April 3

9:30 a.m. General Session

Introduction: R. D. Yarbrough, general chairman
Address of Welcome: Gov. J. P. Coleman
Address of Welcome: Mayor A. C. Thompson
Address: J. O. Emmerich

Luncheon

Address: M. S. Coover, president AIEE
Talk on Satellites: W. H. McDonald

2:00 p.m. Communications

DP.* Communication Industries Problems of the Past with Some Prediction for the Future. *R. G. Elliot*
DP.* Short Haul Telephone Equipment and Engineering. *Frank Bates*
DP57-391. The Application of Negative Impedance on Long Rural Telephone Lines. *H. T. Uthlaut*

2:00 p.m. Distribution and Transmission

DP.* Combined Single Phase and Three Phase Loading of Open Y and Open Delta Transformer Banks. *H. M. Bankus, J. E. Gerngross*
DP.* The Causes of 3Φ Voltage Unbalance and Their Effects on Induction Motor Performance and Protection. *H. I. Madden, C. A. Becnel*
DP.* Series Capacitors with Distribution Transformers. *John Sainz*
DP.* Derivation of Unbalance Tolerance in 3Φ Systems. *A. G. Cook*

2:00 p.m. Metals and Insulated Cables

DP.* The Electrical Pig. *H. W. Adams*
DP.* High Strength Aluminum Alloy Conductors. *Dr. E. W. Greenfield*
DP.* Aluminum Tubular Bus Conductors for Outdoor Substations. *Dixon Lewis*

*District papers will not be printed by the Institute; however, they may be available at the meeting at the discretion of the author.

DP.* Recent Development in Polyethylene Insulating Materials. *J. A. Snyder*

Thursday, April 4

9:00 a.m. Computers

DP.* Principles of Analog Computers. *H. A. Owen, Jr.*
DP.* An Analog Application: The Computation of Rocket Flight. *Dr. E. H. Tompkins, Jr.*
DP.* Principles of Digital Computers. *Dr. V. S. Carson*
DP.* An Application of Digital Techniques to Data Processing. *B. W. Richardson*
DP.* Panel Discussion on Other Applications of Computers. *H. E. Whitted, H. A. Owen, Jr., Dr. E. H. Tompkins, Dr. V. S. Carson, B. W. Richardson*

9:00 a.m. Communications

DP.* Carrier System as Applied to Subscriber Line Usage. *J. D. Howard, Jr.*
DP.* P1 Rural Carrier Systems. *R. F. Clark*
DP.* Memory-Logic—What Electronics Can Do. *J. H. Felker*

2:00 p.m. Transformers

DP57-392. New Concepts in Evaluating Electric Equipment Insulating System—The Problems Encountered. *M. L. Manning*
DP.* A New Approach to the Problem of Transformer Noise. *J. R. Mann*
DP.* Effect of Manufacturing Process on Dielectric Strength of Transformer Materials. *Dr. W. T. Sackett*
DP.* Progress in Power Transformer Development. *L. Wethetill*

2:00 p.m. Computers

DP57-393. Synthesis of Closed Loop System Using Curvilinear Squares. *J. N. Embler, C. H. Weaver*
DP.* Electronic Computer Machines. *Dr. S. L. Jamison*
DP.* Electronic Aircraft Navigation. *Fritz Schawaennele*

2:00 p.m. Transmission and Distribution

DP.* High Voltage Measurements and Equipment Surges on Transmission Lines. *J. W. Skoaglund*
DP.* A New Approach to the Calculation of Lightning Performance of Transmission Lines. *C. F. Wagner*
DP.* Fiber-Glass Poles and Crossarms. *W. F. Swan*

Evening—Dinner Dance

VIEW of downtown Jackson, Miss., scene of April 3-5, 1957, District 4 Meeting. The state capitol and state office buildings are shown in the foreground.

Friday, April 5

9:00 a.m. Protective Devices

DP57-394. The New Thyrite Magne-Valve Distribution arrester. *G. E. Desauliners, E. C. Dakshang, E. A. Evans, T. J. Carpenter*
DP.* Interrupting Test—High Voltage Expulsion Fuses. *T. A. Burdeshaw*
DP.* Load Switching's Future—Unlimited. *John Conrad*
DP.* A New Fuse Link for Distribution Transformers. *T. W. Curtis, I. W. Enk*

9:00 a.m. Chemical Industry

DP.* Selection and Electrical Equipment for the Chemical Industry. *W. H. Plengs*
DP.* Cathodic Protection Grounded Techniques. *J. E. James*
DP.* Cathodic Protection as Applied to Cellular Type Submerged Shipway Bulkhead. *O. J. Streever*
DP57-395. A New Voltage Circuit for Semiconductor Rectifiers. *I. K. Dortort*
DP.* Aluminum Production. *H. W. Graybill*

2:00 p.m. Power Generation

DP.* Gas Turbines in Industry. *W. B. Wilson*
DP.* Automatic Station Logging. *Ted Gluck*
DP.* The Need and Proposed Use of an Analog Computer in Steam Power Station. *F. W. Shipley*
DP.* Utilization of Engineering Manpower in Large Reactor Design. *D. W. McLenegan*

2:00 p.m. Radio-TV-Microwave-Telemetering

DP.* New Microwave Equipment. *C. L. Dodd*
DP.* Problems of Laying Out and Operating Microwave System. *G. R. Ransom*
DP.* Selective Telemetering for Gas Pressure Station Control. *M. E. Fortest*
DP.* Systems Design in the Application of Power Line Carrier. *K. P. Park*

2:00 p.m. System Engineering

DP.* Present Day Trends in Industrial Distribution. *C. F. Kucera*
DP.* Survey of Arc Furnace Installation. *B. L. Lloyd*

1957 Nuclear Congress Being Held March 11-15, in Philadelphia, Pa.

THE 1957 NUCLEAR CONGRESS, to be held at the Philadelphia, Pa., Convention Hall, March 11-15, under the co-ordination of Engineers Joint Council (EJC), has been described as "possibly the most significant event of its kind ever held in this country."

Included in the congress are four major events one of which is the Second Nuclear Engineering and Science Conference coordinated by EJC on behalf of 20 engineering and technical societies, including the AIEE.

The Fifth Hot Laboratories and Equipment Conference, the National Industrial Conference Board Fifth Atomic Energy in Industry Conference, and the International Atomic Exposition will also be part of the congress.

More than 40 major topics will be considered at the congress, including nuclear generating stations, reactors for ship propulsion, disposal of radioactive wastes, production of atomic fuels, legislative and legal problems, atomic energy developments abroad, and practical, commercial applications of the atom in such fields as chemical production and food processing.

In revealing details of the program, T. A. Marshall, Jr., congress manager, said, "The tremendous scope of this congress demonstrates the extent to which atomic energy is becoming a day-to-day industrial operation. Rapid growth and even more rapid change in the field have created a demand for a comprehensive program of this kind where specialists and industrial leaders can assemble and, in a short time, bring themselves up to date on new developments. Recent decisions by the Atomic Energy Commission to expedite America's nuclear power program emphasize the fact that we can expect important, constructive results from this congress for years to come."

Copies of the advance congress program may be obtained by writing to Engineers Joint Council, 29 W. 39th St., New York 18, N. Y., or from any participating society.

The tentative technical program for the Second Nuclear Engineering and Science Conference follows. Preprints of numbered papers only may be obtained from EJC at the address previously mentioned for 30¢ per paper.

Monday, March 11

9:30 a.m. Plant Containment Concepts and Design

Chairman: L. R. Gaty
Vice-Chairman: W. C. Siler

Consolidated Edison Containment System. *H. F. Dobel, D. W. Montgomery*, Babcock & Wilcox Co.

Containment for the EBWR. *L. W. Fromm, A. Heineman*, Argonne National Laboratory

Nuclear Systems Containment Vessels. *A. J. Raymo*, General Electric Company

9:30 a.m. Fuel Production

Cochairmen: F. L. Cuthberth and Floyd Culler

57-NESC-45. Pilot Plant Studies on Nonaqueous Extractive Methods for Western Uranium Ores. *D. D. Foley, W. A. Meeley, R. B. Filbert*, Battelle Memorial Institute

57-NESC-48. Refining of Uranium Ore Concentrates. *D. S. Arnold, B. G. Ryle*, The National Lead Company of Ohio

57-NESC-46. Uranium Recovery at the Oak Ridge Gaseous Diffusion Plant. *R. J. Clouse, J. Dykstra, B. H. Thompson*, Union Carbide Nuclear Co.

57-NESC-47. The Uranyl Ammonium Phosphate Process for Recovery of Uranium from MgF_2 Slag Scrap. *E. R. Johnson, E. O. Rutenkroger, A. E. Kreusmann, B. C. Doumas*, The National Lead Company of Ohio

57-NESC-49. Methods for Production of Thorium Metal. *O. C. Dean*, Oak Ridge National Laboratory

9:30 a.m. Protection of Water Supplies

Chairman: F. S. Friel
Vice-Chairman: S. S. Baxter

Radioactive Tracers in the Field of Sanitary Engineering. *Conrad Straub, Richard Straub*, Robert A. Taft Sanitary Engineering Center

57-NESC-21. Stream Surveys for Radioactive Waste Control. *E. C. Tsivoglou, W. H. Ingram*, Robert A. Taft Sanitary Engineering Center; *E. D. Harward*, U.S. Atomic Energy Commission

Radiochemical Procedures for the Identifications of the More Hazardous Nucleides. *B. Kahn*, Oak Ridge National Laboratory; *A. Goldin*, Robert A. Taft Sanitary Engineering Center

9:30 a.m. Educational Use of Reactors

Chairman: C. F. Bonilla
Vice-Chairman: W. W. Miller

The Water Boiler as an Instructional Tool. *C. K. Beck*, U.S. Atomic Energy Commission

Educational Uses of the Small 5-Watt Laboratory Reactor. *J. W. Flora*, Atomics International

The Portable Polyethylene-Moderated Training and Research Reactor (AGN-201). *A. T. Biehl, R. A. Fayram*, Aerojet-General Nucleonics

The Thermal Test Reactor. *H. B. Stewart, G. B. Gavin, R. E. Slovacek*, Knolls Atomic Power Laboratory

Reactor Experiments in ORSORT. *Herbert Pomerance*, Oak Ridge School of Reactor Technology

Reactor Experiments at ISNSE. *Harry Bryant, R. H. Armstrong, C. N. Kelber, D. H. Lennas, B. I. Spinrad*, Argonne National Laboratory

Educational Uses of the "Pickle-Barrel." *R. M. Stephenson, Henrik Ager-Hanssen*, New York University

2:30 p.m. Fuel Cycle Interrelationships

Cochairmen: E. B. Gunyou and J. C. Robinson

57-NESC-1. Reactor Complex Interdependence Resulting from Fuel Recycle. *W. A. Rodger, S. Lawroski*, Argonne National Laboratory

57-NESC-22. Reactor Design and the Fuel Cycle. *R. B. Spooner*, Koppers Company, Inc.

57-NESC-42. The Fuel Cycle from the Standpoint of the Fuel Processor. *C. E. Stevenson*, Phillips Petroleum Co.

57-NESC-41. Fuel Cycles in Single-Region Thermal Reactors. *T. H. Pigford, Manson Benedict*, Massachusetts Institute of Technology

2:30 p.m. Merchant Ship Safety

Chairman: H. W. Pierce
Vice-Chairman: H. M. Tiedemann

57-NESC-11. Development of Safety Standards for Nuclear Propulsion of Merchant Ships. *C. P. Murphy*, U.S. Coast Guard Headquarters; *A. R. Gatewood*, American Bureau of Shipping

Some Possible Safety Measures for Nuclear Merchant Ships. *R. H. Fayram*, Aerojet-General Nucleonics

2:30 p.m. Waste Disposal I

Chairman: J. C. Oever
Vice-Chairman: J. A. Lieberman

57-NESC-54. Disposal of Fission Products in Glass. *R. W. Durham*, Atomic Energy of Canada, Ltd.
Over-all Geologic Approach to Disposal. *H. H. Hess*, Princeton University

57-NESC-53. Separation of Cesium and Strontium from Calcined Metal Oxides as a Process in Disposal of High Level Wastes. *A. Abriss, J. J. Reilly, E. J. Tuthill*, Brookhaven National Laboratory

Problems of State Enforcement Agencies in Handling Treatment and Disposal of Radioactive Wastes. *E. C. Jensen*, Washington State Department of Health

2:30 p.m. Reactor Operation and Maintenance

Chairman: P. N. Ross
Vice-Chairman: R. G. Lorraine

57-NESC-62. The Homogeneous Reactor Test Mockup. *I. Spiewak, H. L. Falkenberry*, Oak Ridge National Laboratory

57-NESC-24. Some Operational Problems of the Nuclear Power Plant. *R. L. Witzke, A. R. Jones*, Westinghouse Electric Corporation

Opportunities for Reducing the Investment and Operating Costs of Utility Side Nuclear Power Plants. *H. B. Hughes*

Tuesday, March 12

9:30 a.m. Fuel Manufacture

Cochairmen: F. G. Foote
R. B. Briggs

Fabrication of Irradiated Reactor Fuels by Semi-automatic Remote Controlled Equipment. *A. B. Shuck,* Argonne National Laboratory

High Uranium Alloy Fuel Plate for the Experimental Boiling Water Reactor. *R. E. Macherey, C. H. Bean,* Argonne National Laboratory

Oxide Fuel Elements for Borax-IV. *J. H. Handwerk, R. A. Noland,* Argonne National Laboratory

Preparation and Properties of Aqueous Thorium-Uranium Oxide Slurries. *V. D. Allred, C. E. Schilling, J. P. McBride,* Oak Ridge National Laboratory

9:30 a.m. Standardization in the Nuclear Field

Panel Session Sponsored by ASA

Chairman: Admiral W. Augustus Kitts, III
Vice-Chairman: Vice Admiral G. F. Hussey

General and Administrative Standards. *W. A. Kitts, III,* General Electric Company

Nuclear Instruments. *Nicholas Anton,* Anton Electronic Laboratories, Inc.

Electrical Requirements for Nuclear Reactors and Atomic Systems. *R. C. Sogge,* General Electric Company.

Chemical Engineering in the Nuclear Field. *R. P. Genereaux,* E. I. du Pont de Nemours & Co. (Inc.)

Reactor Hazards. *Harvey Wagner,* The Detroit Edison Co.

Radiation Protection in the Nuclear Field. *W. A. McAdams,* General Electric Company

9:30 a.m. Waste Disposal II

Chairman: R. J. Morton
Vice-Chairman: B. A. Poole

Geological Considerations of Waste Disposal—Thermal Considerations. *H. E. Skibitzke,* U.S. Geological Survey

57-NESC-1. Atomic Waste Disposal by Injection into Aquifers. *E. Raedder,* U.S. Geological Survey

Disposal of Radioactive Wastes. *Abel Wolman,* Johns Hopkins University

Disposal of Radioactive Wastes in Reverse Wells. *W. J. Kaufman*

9:30 a.m. Primary Coolant Systems

Chairman: W. H. Jens
Vice-Chairman: J. P. Hartnett

Engineering Consideration in the Use of an Organic Reactor Coolant. *W. E. Parkins et al,* Atomics International

Boiling Water as a Primary Coolant. *Sam Untermeyer,* General Electric Company

Gas Coolant for Nuclear Reactors. *M. Silberberg,* Ford Instrument Company

Operation Sodium Coolant SRE. *J. E. Nolan,* Westinghouse Electric Corporation

Operational Experience with a UO-NaK Slurry in a Loop at 600 C. *H. E. Flotow, R. D. Carlson, B. M. Abraham,* Argonne National Laboratory

2:30 p.m. Plant Components—Small

Chairman: J. F. Roberts
Vice-Chairman: Leonard Koch

Electromagnetic and Mechanical Pumps of EBR Sodium System. *R. A. Jarass, O. H. Seim,* Argonne National Laboratory

Use of Clad Piping. *J. H. Proctor,* Lukens Steel

Piping as Applied to Nuclear Energy Applications. *D. B. Rossheim, J. J. Murphy, C. R. Soderberg, H. S. Blumberg,* M. W. Kellogg Co.

57-NESC-33. On Quality Requirements for Steel Valves for Nuclear Power Plants. *J. J. Kanter,* Crane Company

60 Cycle Induction Heating of Sodium Systems. *R. A. Jarass, O. H. Seim,* Argonne National Laboratory

2:30 p.m. New Limits and Codes for Radiation Protection

Chairman: J. W. Healy
Vice-Chairman: C. M. Paterson

Changes in Maximum Permissible Exposure Values Recommended in 1956 by the International Commission on Radiological Protection. *K. Z. Morgan,* Oak Ridge National Laboratory

The Impact of the Lowered Radiation Exposure Limits on Radiation Control Problems. *L. S. Taylor,* National Bureau of Standards

Status of Radiation Protection Legislation and Codification. *W. A. McAdams,* General Electric Company

Regulations Controlling the Use of Radioactivity by AEC Licenses. *Farrest Western,* Atomic Energy Commission

Statistics on Radiation Exposures for Use in Labor, Insurance, Economic, and Scientific Studies. *W. D. Claus,* Atomic Energy Commission

2:30 p.m. Shielding—Structural Protection and Control of Fission Products

Chairman: J. G. Terril, Jr.
Vice-Chairman: H. L. Bowman

Control of Radioactive Material at the Pressurized Water Reactor. *J. R. La Pointe,* Westinghouse Electric Corporation

Structural Properties of Magnitite Concrete. *J. M. Raphael,* University of California

57-NESC-51. Materials of Biological Shielding. *H. M. Glenn,* Oak Ridge National Laboratory

Structural Features of the Waste Disposal System for the Shippingport Atomic Power Station, Shippingport, Pa. *H. T. Evans,* Stone & Webster Engineering Corp.

The Application of Radioisotopes to the Measurement of Soil Moisture Content and Density. *P. F. Carlton,* Ohio River Division Laboratory, Corps. of Engineers, U.S. Army

2:30 p.m. Spent Fuel Processing—Aqueous

Chairman: R. B. Richards

Head-End Steps in Preparation of Fuels for Aqueous Processing. *J. A. Buckham,* Phillips Petroleum Co.

57-NESC-59. New Developments in Head-End Methods for Preparation of Fuels for Aqueous Processing. *R. E. Blanco, J. E. Savolainen,* Oak Ridge National Laboratory

57-NESC-58. Comments on Waste Disposal at Hanford. *M. J. Stedwell, R. E. Burns,* Hanford Atomic Products Operation

An Ion Exchange Process for the Recovery of Plutonium from Irradiated Fuels. *A. M. Aikin,* Atomic Energy of Canada, Ltd.

Waste Disposal as Related to Chemical Processing. *G. G. Robeck, C. P. Straub,* Robert A. Taft Sanitary Engineering Center

An Electrolytic Recycle Process for Waste Treatment. *H. W. Alter, D. L. Barney,* Knolls Atomic Power Laboratory

57-NESC-57. Nuclear Safety Considerations in Reactor Fuels Processing Plant Design. *Norman Ketzlach,* Hanford Atomic Products Operation

Wednesday, March 13

9:30 a.m. Plant Components—Large

Chairman: A. N. Anderson
Vice-Chairman: M. C. Beekman

Boilers for Nuclear Power Plants. *John Cartinhour,* Foster Wheeler Corp.

Pressure Vessels for Nuclear Power Plants. *S. L. Lindbeck, Arnold Halporn, Jr.* Westinghouse Electric Corp.

Basic Equations for Predicting Performance of a Nuclear Power Plant Pressurizer. *T. Glasser,* Knolls Atomic Power Laboratory

Fuel Handling System for a Fast Breeder Reactor. *J. E. Seward, C. P. Nash,* Atomic Power Development Associates

9:30 a.m. Radiation Processing

Chairman: P. N. Powers
Vice-Chairman: A. V. Peterson

Use of Ionizing Radiations in Control of Parasitic Infections. *J. Villella, H. I. Gomberg, S. E. Gould,* University of Michigan

Basic Concepts in the Application of Ionizing Radiations to Foods For Preservation. *D. H. Rest, B. H. Morgan, G. E. Danald, G. E. Tripp, M. Simon,* Quartermaster Corps, U.S. Army

A Megacurie Cobalt-60 Food Irradiator. *B. Manowitz, O. A. Kuhl, Leonard Galantier,* Brookhaven National Laboratory

Peacetime Utilization of Ionizing Radiation in the Chemical Industry. *K. H. Sun,* Radiation & Nucleonics Laboratory, Westinghouse Electric Corporation

The Nuclear Reactor as an Instrument of Medical Research and Therapy. *E. Stickley, G. S. Robertson, L. E. Farr,* Brookhaven National Laboratory

9:30 a.m. Fuel Processing—Nonaqueous

Chairman: S. Lawroski
Cochairman: S. M. Stoller

57-NESC-27. Liquid Metal Fuel Reactor (LMFR) In-Pile Fuel Processing Loop. *C. Raseman, H. Sasskind, G. H. Waide,* Brookhaven National Laboratory

57-NESC-56. Decontamination of Irradiated Uranium by Fluoride Volatility Process. *W. J. Mecham, R. W. Kessie, W. B. Seefeldt, R. C. Liimatainen,* Argonne National Laboratory

57-NESC-55. Magnesium Extraction Process for Plutonium Separation from Uranium. *I. O. Winsch, L. Burris, Jr.,* Argonne National Laboratory

57-NESC-26. Conceptual Design of Pyrometallurgical Reprocessing Plant. *Louis Basel, Joseph Koslow,* United Engineers & Constructors, Inc.

57-NESC-23. Conceptual Design of Remote Fabrication Plant. *C. M. Ladd,* Atomic Power Development Associates; *J. Koslow,* Vitro Corp. of America

9:30 a.m. Reactor Design

Chairman: L. Macklin
Vice-Chairman: D. J. Woodruff

Engineering Aspects of the Nuclear Design of Power Reaction. *M. J. Galper, O. J. Woodruff, Jr.,* Westinghouse Electric Corporation

Nuclear Powered Gas Turbine for Light Weight Power Plants. *F. Hummitt, H. A. Ohlgren,* University of Michigan

Considerations in the Design of Pressurized Water Reactor Plants. *J. E. Nolan, J. R. LaPointe,* Westinghouse Electric Corporation

Design and Construction of the Engineering Test Reactor. *P. D. Bush,* Kaiser Engineers

Stress Corrosion Cracking Problems in the Homogeneous Reactor Test (HRT). *E. G. Bohlman,* Oak Ridge National Laboratory; *G. M. Adamson,* Oak Ridge National Laboratory

2:30 p.m. Reactor Core Design

Chairman: K. W. Davis
Vice Chairman: W. J. McCarthy, Jr.

EBR-II Control Drive Mechanism. *Ernest Hutter,* Argonne National Laboratory

On the Significance of Reynolds Number on Reactor Design. *F. L. Jackson, J. P. Waggener,* Proj. Eng. Nuclear Power Section; *J. S. Busch, L. H. Harman,* Westinghouse Atomic Power Division

57-NESC-66. Absorber Materials for Reactor Control. *W. K. Anderson, D. N. Bunning,* Knolls Atomic Power Laboratory

2:30 p.m. Uranium Metallurgy and Radiation Effects

Chairman: Benjamin Lustman
Vice-Chairman: C. A. Bruch

57-NESC-8. The Effect of Cooling Rate on the Nucleation and Growth of Beta Uranium Hydride in Metallic Uranium. *H. R. Gardner, J. W. Riches,* Hanford Atomic Products Operation, General Electric Company

57-NESC-14. Effects of Alloying Element Additions of Al, Si, Mo, Ti, V, Zr and Nb on the Thermal Cycling Stability of Uranium. *S. T. Zegler, H. H. Chiswik,* Argonne National Laboratory

A Study of the Tensile Transition in Alpha Uranium. *L. L. Marsh, Jr.,* Battelle Memorial Institute

57-NESC-15. Metallographic Studies on Neutron-Irradiated Nonfissionable Metals. *C. A. Bruch, W. E. McHugh, L. J. Doig,* Knolls Atomic Power Laboratory

57-NESC-63. Effects of Grain Size on the Growth of Alpha-Uranium under Irradiation. *R. Resnick, L. Seigle,* Sylvania Electric Products, Inc.

57-NESC-13. The Effect of Irradiation on the Tensile Properties of Uranium. *R. E. Hueschen, R. S. Kemper, S. K. Kelly,* General Electric Company

2:30 p.m. Reactor Plant Instrumentation

Chairman: E. E. Lynch
Vice-Chairman: T. S. Gray

57-NESC-34. Health Physics Instrumentation for a Power Reactor. *G. H. Whipple,* University of Rochester

A Resistance Temperature Detector for Submarine Reactor Service. *F. R. Sias, R. J. Cushing,* General Electric Company

57-NESC-38. Safety Circuit Development at Brookhaven National Laboratory. *J. E. Binns, W. Lones, D. G. Pitcher,* Brookhaven National Laboratory; *M. Melice,* Nuclear Development Corp. of America

Recent Developments in the Reactor Instrumentation at the Knolls Atomic Power Laboratory. *R. S. Stone,* General Electric Company

Ultrasonic Flowmeter Monitors Reactor Heat Exchange Circulation. *M. Kobbenz, R. M. Spiegel, S. Kass*

57-NESC-50. Radiation Flux Conditions in Radioactive Media with Applications to Radiation Monitoring. *B. E. Bahlin,* Minneapolis-Honeywell Regulator Co.

2:30 p.m. Fuel Cycle Economics

Cochairmen: M. Levenson and J. Hogerton

Fuel Processing and Recycling for Natural Uranium Power Reactors. *H. K. Rae,* A.E.C.L.

The Economics of Ceramic Fuel Elements. *J. R. Johnson,* Minnesota Mining and Manufacturing Co.

57-NESC-52. The Economic Background for the Competitive Development of Nuclear Power. *H. W. Nelson, W. R. Keagy, Jr.,* Battelle Memorial Institute

Some Fuel Fabrication Economics Parametric Studies. *Donald Kallman,* Babcock & Wilcox Co.

Thursday, March 14

9:30 a.m. Reactor Control and Simulators

Chairman: Rufus Oldenberger
Vice-Chairman: M. A. Schultz

57-NESC-25. Dynamic Simulation of a Fast Reactor System. *R. G. Olson,* Atomic Power Development Associates, Inc.

Control Problems in Nuclear Power Plants. *J. E. Owens,* Atomics International

57-NESC-19. The Development of a Universal Type Control Drive Mechanism for Nuclear Reactors. *Charles Hinrichs, Gilbert Rolan,* American Machine & Foundry Co.

57-NESC-60. The Logarithmic-Diode Counting-Rate Meter and Period Meter. *B. B. Barrow,* Hycon Eastern Inc.

Conference Papers Open for Discussion

Conference papers listed below have been accepted for AIEE *Transactions* and are now open for written discussion until April 1. Duplicate double-spaced typewritten copies of each discussion should be sent to E. C. Day, Assistant Secretary for Technical Papers, American Institute of Electrical Engineers, 33 West 39th St., New York 18, N. Y., on or before April 1.

56-767 A Transient Stability and Voltage Study for a Modern Oil Refinery Distribution System. *C. W. Boice, S. R. Durand, and D. Dalasta*

Preprints may be purchased at 40¢ each to members, 80¢ each to nonmembers, if accompanied by remittance or coupons. Please order by number and send remittance to: AIEE Order Department, 33 West 39th St., New York 18, N. Y.

9:30 a.m. Natural Resources I

Chairman: L. R. Page
Vice-Chairman: R. L. Faulkner

57-NESC-31. Exploration, Resources, and Production of Uranium. *R. D. Mininger,* U.S. Atomic Energy Commission

Recent Advances in the Geology of Uranium Developments in Geochemistry and Mineralogy. *R. M. Garrels,* Harvard University

Laboratory Investigations on the Origin of Uranium and Vanadium in the Ores of the Colorado Plateau. *A. M. Pommer,* U.S. Department of the Interior, Geological Survey

Crystal Chemistry of Carnotite. *P. B. Barton, D. E. Appleman,* U.S. Geological Survey

New Developments in Methods of Radiometric Assay for Uranium. *H. L. Volchok,* Isotopes Inc.

9:30 a.m. Metallurgy of Reactor Materials

Chairman: A. R. Kaufman
Vice-Chairman: Bruce Dunnington

57-NESC-16. Transformation Kinetics and Mechanical Properties of 0.5 and 1.0 w/o Molybdenum-Uranium Alloys. *E. G. Zukas,* University of California

57-NESC-12. The Metastable Gamma Phase in Uranium Base Molybdenum Alloys. *W. A. Bostrom, E. K. Halteman,* Westinghouse Electric Corporation

57-NESC-4. The Corrosion of Uranium-Molybdenum Alloys in High Temperature Water. *M. W. Bukart, I. Cohen,* Bettis Plant; *R. K. McGeary,* Westinghouse CAPA

57-NESC-7. Self-Diffusion in Thorium. *C. J. Meechan,* North American Aviation, Inc.

57-NESC-6. Internal Friction and Shear Modulus of Thorium at High Temperatures. *C. E. Dixon, H. Hori,* Atomics International

57-NESC-9. Effect of Cold Work on the Mechanical Properties of Zircaloy-2. *F. Forscher,* Westinghouse Electric Corporation

9:30 a.m. Heat Transfer and Heat Evolution

Chairman: Lee Chajson
Cochairman: Ken Coulter

57-NESC-30. Nusselt Values for Estimating Turbulent Liquid Metal Heat Transfer in Noncircular Ducts. *J. P. Hartnett, T. F. Irvine, Jr.,* University of Minnesota

57-NESC-64. Natural Convection Inside Horizontal Cylinder. *W. R. Martini, S. W. Churchill,* University of Michigan

57-NESC-29. The Integral-Spectrum Method for Gamma Heating Calculations in Nuclear Reactors. *L. G. Alexander,* Oak Ridge National Laboratory

2:30 p.m. Natural Resources II

Chairman: C. A. Anderson
Vice-Chairman: P. F. Kerr

57-NESC-44. Patterns of Disequilibrium in Radioactive Ores. *J. H. Rosholt,* U.S. Geological Survey

57-NESC-32. Zirconium: Mineralogy and Geochemistry. *Clifford Frondel,* Harvard University

Environment of Some Wyoming Uranium Deposits. *E. W. Gruit, Jr.,* U.S. Atomic Energy Commission

57-NESC-28. Uranium West of the Colorado Plateau. *D. L. David, B. J. Sharp,* U.S. Atomic Energy Division

57-NESC-43. Recent Uranium Redistribution in the Cameron, Arizona Deposits. *Ralph Austin,* U.S. Atomic Energy Commission

Natural Occurrence of Thorium. *George Phair,* U.S. Geological Survey

2:30 p.m. Metallurgy of Uranium-Zirconium and Uranium-Niobium Alloys

Chairman: H. A. Wilhelm
Vice-Chairman: H. H. Chiswik

57-NESC-20. The Effect of Oxygen on Zirconium-Uranium Epsilon-Phase Alloys. *A. A. Bauer, F. A. Rough, H. A. Saller,* Battelle Memorial Institute

The Transformation Kinetics of Uranium-Zirconium Alloys Containing 50 and 60% Uranium. *J. J. Kearns,* Westinghouse Electric Corporation

57-NESC-3. The Corrosion Properties of Zirconium-Base Fuel Alloys. *S. Kass,* Nuclear Core Department, Bettis Plant

Corrosion Behavior of Intermediate Uranium-Zirconium Alloys in High-Temperature Water. *K. M. Goldman, S. Kass,* Westinghouse Electric Corporation

57-NESC-5. Uranium-Columbium Alloy Diagram. *B. A. Rogers, D. F. Atkins, E. J. Manthos, M. E. Kirkpatrick,* Iowa State College

57-NESC-10. Continuous Cooling Transformation Studies for the U-10 wt Per Cent Nb Alloy. *J. S. Parry, R. J. van Thyne, D. J. McPherson,* Illinois Institute of Technology

57-NESC-65. Effects of Irradiation on Powder Compacts of Uranium and Some Uranium-Base Alloys. *J. H. Kittel, S. H. Paine,* Argonne National Laboratory

Radiation Stability Studies of Binary Uranium Alloys. *G. D. Calkins, J. E. Gates, A. A. Bauer, F. A. Rough,* Battelle Memorial Institute

2:30 p.m. Reactor Instrumentation Development

Chairman: G. W. Morton
Vice-Chairman: H. A. Lammonds

57-NESC-40. A Wire-Activation Technique for Reactor-Flux-Profile Measurements. *A. E. Klickman,* Battelle Memorial Institute; *F. R. DeFalco,* Westinghouse Electric Corporation

57-NESC-39. Development of a Thermal-Neutron-Flux-Measuring Instrument. *C. F. Weaver, C. K. Smith, J. W. Chastain,* Battelle Memorial Institute

57-NESC-35. Solid-State Neutron-Flux Measuring System. *T. S. Gray, R. H. Spencer,* Massachusetts Institute of Technology; *W. M. Grim, Jr.,* General Electric Laboratories, Inc.; *F. S. Replogle, Jr.,* Schlumberger Well Surveying Corp.

57-NESC-36. Acoustic Ionization Chamber. *D. R. Whitehouse;* Massachusetts Institute of Technology; *F. S. Replogle, Jr.,* Schlamberger Well Surveying Corp.

57-NESC-37. Millimicrosecond Coincident System. *J. G. Lundholm, Jr., J. A. Bjorkland, A. C. Menius, Jr.,* North Carolina State College

57-NESC-61. Evolution of Neutron Sensing Elements—Scientific Laboratory to Industrial Application. *Leslie Johnson,* Neutronics Laboratory

2:30 a.m. Problems Related to Heat Transfer

Chairman: S. W. Churchill
Vice-Chairman: R. V. Bailey

Transient Thermodynamics of Reactor and Process Apparatus. *D. H. Brown,* Knolls Atomic Power Laboratory

57-NESC-2. Electrical Problems in Electrical Burnout Testing of Nuclear Fuel Elements. *T. W. Hunt,* Westinghouse Electric Corporation

Mechanical and Thermal Problems of Water Cooled Nuclear Power Reactors. *N. J. Palladino, J. Sherman,* Westinghouse Electric Corporation

Time and Temperature Dependence of Thermal Stresses in Cylindrical Reactor Fuel Elements. *K. H. Mereckta,* General Electric Company

Des Moines Will Be Host to Great Lakes District Meeting

The AIEE Great Lakes District Meeting will be held in Des Moines, Iowa, at the Fort Des Moines Hotel on April 15-17, 1957. One highlight of the technical program of this meeting will be a symposium on the problems of acquisition of right-of-way for the construction of transmission lines. Representatives of the utilities throughout the District will present their individual problems and discuss the various ways in which each of them have expedited the acquisition of new rights-of-way.

On Monday evening, AIEE President M. S. Coover will be the guest of honor at a reception at the Fort Des Moines Hotel.

The principal speaker of the meeting banquet on Tuesday evening will be E. S. Lee, past president of the Institute.

The inspection trip committee under the chairmanship of C. C. Doerrie has announced trips to the Maytag manufacturing plant at Newton, Iowa; to the Solar Aircraft plant in Des Moines, featuring special processes in the development and production of high-temperature-resistant metals; and to the atomic energy research facilities at Iowa State College, in Ames, featuring the research laboratories for basic research in metallurgy and rare earth separation, and the synchrotron laboratory. Special trips may be arranged to visit the facilities of the local utility, featuring their control and dispatching center in downtown Des Moines, a short walk from the hotel.

A committee under the chairmanship of Mrs. N. B. Gussett is making a special effort to provide a program for the ladies, including inspection trips to the Meredith Publishing Co., to the Des Moines Art Center, and a trip to the Wakonda Club for luncheon on Tuesday.

The general chairman of this meeting is K. R. Brown of Brown Engineering Co., Des Moines. Committee chairmen include

Future AIEE Meetings

Textile Conference*
Georgia Institute of Technology,
Atlanta, Ga.
March 7-8, 1957

EJC Nuclear Engineering and Science Congress*
Convention Hall, Philadelphia, Pa.
March 11-15, 1957

AIEE-ASME Engineering Management Conference*
Penn-Sheraton Hotel,
Pittsburgh, Pa.
March 27-28, 1957

Paper and Pulp Conference*
Georgia Institute of Technology,
Atlanta, Ga.
March 28-29, 1957

Southern District Meeting*
Hotel Heidelberg, Jackson, Miss.
April 3-5, 1957

Rubber and Plastics Conference*
Akron, Ohio
April 8-9, 1957

AIEE-AWS Electric Welding Conference*
Convention Hall
Philadelphia, Pa.
April 8-12, 1957

Great Lakes District Meeting*
Hotel Fort Des Moines,
Des Moines, Iowa
April 15-17, 1957

AIEE-IRE Solid State Dielectric and Magnetic Devices Conference*
Catholic University,
Washington, D.C.
April 22-23, 1957

Electric Heating Conference*
Commodore Perry Hotel,
Toledo, Ohio
April 23-24, 1957

North Eastern District Meeting*
Wendell-Sherwood Hotel,
Pittsfield, Mass.
May 1-3, 1957

AIEE-IRE-RETMA-WCEMA Electronic Components Conference*
Morrison Hotel, Chicago, Ill.
May 1-3, 1957

East Central-Middle Eastern District Meeting
Biltmore Hotel, Dayton, Ohio
May 7-9, 1957
(Final date for †TP—closed, §DP Syn.—closed, DPMs—March 1)

Aircraft Electrical Equipment Conference
Dayton, Ohio
May 7-9, 1957
(Final date for †TP—closed, ‡CP Syn—closed, CPMs—March 1)

Domestic Appliances Conference
Detroit, Mich.
May 20-21, 1957
(Final date for †TP—closed, ‡CP Syn.—March 7, CPMs—March 15)

American Power Conference
Sherman Hotel, Chicago, Ill.
May 27-29, 1957
(Final date for †TP—closed, ‡CP Syn.—March 14, CPMs—March 22)

AIEE-ISA-IAS National Telemetering Conference
Cortez Hotel, El Paso, Tex.
May 27-29, 1957
(Final date for †TP—closed, ‡CP Syn.—March 14, CPMs—March 22)

Rectifiers in Industry Conference
Morrison Hotel, Chicago, Ill.
June 4-5, 1957
(Final date for †TP—March 4, ‡CP Syn.—March 19, CPMs—March 29)

Summer General Meeting
Sheraton-Mount Royal Hotel,
Montreal, Que., Canada
June 24-28, 1957
(Final date for †TP—March 27, ‡CP Syn—April 9, CPMs—April 19)

Pacific General Meeting
Pasco, Wash.
August 28-30, 1957
(Final date for †TP—May 28, ‡CP Syn—June 14, CPMs—June 24)

AIEE-IRE Magnetic Amplifiers Conference
Penn-Sheraton Hotel,
Pittsburgh, Pa.
September 4-6, 1957
(Final date for †TP—June 4, ‡CP Syn.—June 19, CPMs—June 28)

Petroleum Conference
Philadelphia, Pa.
September 9-11, 1957
(Final date for †TP—June 10, ‡CP Syn.—June 25, CPMs—July 5)

AIEE-IRE Industrial Electronics Conference
Morrison Hotel, Chicago, Ill.
September 24-25, 1957
(Final date for †TP—June 24, ‡CP Syn.—July 10, CPMs—July 19)

AIEE-IRE-RETMA-SMPTE National Electronics Conference
Hotel Sherman, Chicago, Ill.
October 7-9, 1957
(Final date for †TP—July 7, ‡CP Syn.—July 22, CPMs—Aug. 1)

Fall General Meeting
Chicago, Ill.
October 7-11, 1957
(Final date for †TP—June 7, ‡CP Syn.—July 24, CPMs—Aug. 2)

Reliability and Quality Control in Electronics Conference
Silver Spring, Md.
October 10, 1957
(Final date for †TP—July 10, ‡CP Syn.—July 25, CPMs—Aug. 2)

*Final date for submitting papers—closed
†TP—Transactions Paper
‡CP Syn.—Conference Synopsis
CPMs—Conference Manuscript
(The CP Syn. date is 10 days before the CPMs date)
§DP Syn.—District Synopsis
DPMs—District Manuscript
(The DP Syn. date is 10 days before the DPMs date)

R. H. Miller, finance; G. R. Henninger and Robert Ringstrand, publicity; F. E. Baird, meeting rooms; J. E. Lagerstrom, G. R. Town, and L. A. Ware, technical program; R. F. Castner, social chairman; and A. R. Adams, banquets and luncheons.

Information on registration and reservations for hotel space may be obtained from C. E. Lex, General Electric Company, 505 W. 5th St., Des Moines, Iowa.

North Eastern District Meeting Will Take Place May 1-3, 1957

North Eastern District members will travel to the Berkshire Hills of Massachusetts for the 1957 North Eastern Regional meeting May 1-3. Headquarters for the meeting will be at the Wendell-Sherwood Hotel in Pittsfield, Mass.

Plans for interesting technical sessions, social activities, and inspection trips have been completed. The general theme of the meeting is E = IR (Engineering equals Industrial Revolution).

The theme for the meeting results from the increased importance of computers and automation and is intended to recognize the contribution of electrical engineering to the second industrial revolution. Two sessions dealing with computers and data processing plus one devoted to industrial electronics and controls emphasize the role of electricity in relieving workers of the tedium of dull, repetitive operations.

The schedule of the three-day meeting includes sessions in all three major AIEE areas—communication and electronics, applications and industry, and power apparatus and systems. Power generation, transmission and distribution, transformers, communications, heating and air conditioning are among the sessions included at the meeting. In addition, student papers will be presented on Friday, May 3, as part of the special student program.

Inspection trips include visits to Crane & Co. in nearby Dalton, Mass., which is one of the few manufacturers producing all-rag-content paper. Those taking the trip will see the latest paper-making equipment in operation, plus a trip to the company's museum where samples of currency made for almost 50 countries are on exhibition. Another trip will be taken to the Berkshire Woolen Company to see a modern medium-sized mill utilizing the latest intricate cloth-making machines. Called a "novelty" mill in the textile trade because of the large variety of types and colors of the finished cloth, visitors will see the entire process of turning raw wool into finished cloth for men's and ladies' wear.

Highlights of another trip to General Electric's Pittsfield Transformer Plant include the latest IBM-*705* computer used to design power transformers, the world's largest high-voltage laboratory, and the largest anechoic (without echoes) chamber in its own building, in existence today.

Entertainment includes a "get-acquainted" reception on Wednesday, May 1, 1957, from 5:30 to 6:30 p.m. at the hotel. In addition, on Thursday evening, beginning at 6:00 p.m. a cocktail party, smorgasbord dinner and dance will take place in the main ballroom.

Student activities include a breakfast on Friday morning for Student Counselors followed by the presentation of student papers. After a joint Counselor–Student luncheon, the students will visit the General Electric Company plant.

General chairman for the meeting is J. O. Sweeny. W. A. McMorris and T. E. Rodhouse are chairmen of the program and reservation committees respectively. All are employed at General Electric.

AIEE and IRE Plan Joint Symposium

Because of the complex requirements imposed on equipment and components by recent developments in the electrical and electronic fields, it is felt that an understanding of these requirements is greatly needed. With this in mind, the Educational Committee of the Philadelphia Section of the AIEE and the Philadelphia Section of the Institute of Radio Engineers (IRE) are sponsoring a joint symposium, to be entitled "Design for Environment," which will be the first of a series of annual symposiums to deal with this subject.

The first symposium will consist of a series of 6 lectures and will be concerned with the design for nuclear radiation. The speakers will be outstanding men in their fields and will include representatives from Naval Research Laboratories, Atomic Energy Commission, Battelle Institute, and General Electric Company.

The program for the symposium follows:

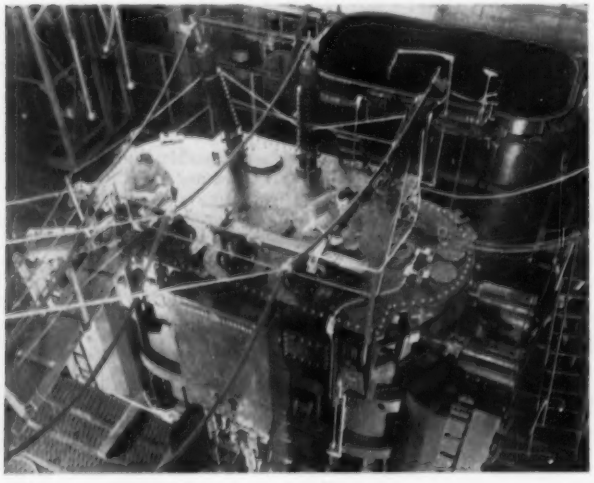
Session 1—Thursday, March 28, 1957
Speaker: Dr. J. H. Crawford, Solid-State Division Atomic Energy Commission Oak Ridge, Tenn.
Description of the Nuclear Environment and Its Importance in Industry.
Basic Principles of Nuclear Radiation and Radiation Damage.

Session 2—Friday, April 5, 1957
Speaker: Herbert Rabin, Naval Research Laboratories, Washington, D. C.
Testing and Measurement Techniques.
Facilities for Irradiation of Materials, Components, and Equipment.
Methods of Monitoring Temperature Radiation Spectrum.

Session 3—Thursday, April 18, 1957
Speaker: Dr. Paul Schall, Battelle Memorial Institute, Columbus, Ohio.
Materials — Radiation Damage and Shielding Effects.

Session 4—Thursday, April 25, 1957
Speaker: Will be from the General Electric Company.
Radiation Effects on Electrical Equipment and Devices.

Session 5—Thursday, May 2, 1957
Speaker: J. C. Pigg, Solid-State Division, Atomic Energy Commission, Oak Ridge, Tenn.
Radiation Effects on Electronic Components.



TESTING of giant power transformers at General Electric's Pittsfield Transformer Plant is one of the sights scheduled for inspection during the North Eastern District Meeting at Pittsfield, Mass., on May 1-3. Headquarters hotel for the meeting is the Wendell-Sherwood. Theme of meeting is "Engineering equals Industrial Revolution." Computers and automation will be stressed.

Bimonthly Publications

The bimonthly publications, *Communication and Electronics*, *Applications and Industry*, and *Power Apparatus and Systems*, contain the formally reviewed and approved numbered papers presented at General and District meetings and conferences. The publications are on an annual subscription basis. In consideration of payment of dues, members (exclusive of Student members) may receive one of the three publications; additional publications are offered to members at an annual subscription price of $2.50 each. Nonmembers may subscribe on an advance annual subscription basis of $5.00 each (plus 50 cents for foreign postage payable in advance in New York exchange). Single copies, when available, are $1.00 each. Discounts are allowed to libraries, publishers, and subscription agencies.

Session 6--Thursday, May 9, 1957

Speaker: Will be from the Air Research Center.

How to Design for the Nuclear Environment.

Meetings will be held at the Philadelphia Electric Co. Auditorium, 9th & Sansom Sts., Philadelphia, Pa., starting at 8:00 p.m.

Advance registration for all 6 lectures is $3.50 for IRE and AIEE members and $4.00 for nonmembers. Registration at door is $4.50 for all 6 lectures and $1.00 for individual meetings. All registrations and checks should be sent to:

W. Kassimir, Atlantic Refining Co.
260 S. Broad St.
Philadelphia 1, Pa.

Why Engineers Unionize Analyzed by Conference Board

ENGINEERING unions now claim as members nearly 60,000 of the nation's 500,000 engineers, according to a study just completed by the National Industrial Conference Board (NICB). While these figures show that engineers are far from constituting a unionized segment of the economy, they do indicate possible dissatisfaction among this group.

To determine why unionism has occurred among a group considered by many as "unorganizable," the Board questioned executives of companies whose engineers were unionized, officials of engineering unions, engineering societies, and engineers themselves. Findings showed that many engineers are not completely happy with their financial position, their status as professionals, and their treatment as "individuals."

The answer to discontent, say union leaders, is unionism. But engineering societies, who believe unionism is incompatible with the engineer's professional status, point out that employers have the power to improve employment standards for engineers.

In a recent Conference Board discussion of this subject, Dr. H. R. Northrup, vice-president, Penn-Texas Corporation, said that management can accomplish the job for the employee-engineer which must be done today by treating engineers "(1) as members of the management organization . . . through such items as fair compensation, practical recognition of professional personnel as part of management, and appropriate methods to bring the grievances of professional employees to the attention of top management, and (2) as members of a profession . . . by including time and facilities for research, study, reading, publishing, and otherwise maintaining professional status, and by placing emphasis not on day-to-day output but on ideas contributing to the long-run worth of the business."

Salary Dissatisfaction

One of the chief financial complaints of engineers, the Conference Board study reveals, is that the earnings differential between salaried engineers and wage earners has become too narrow in many companies. And in terms of fringe benefits, engineers say their former advantage over the production worker has been virtually wiped out. Second major financial complaint is that existing salaries for engineers have not kept pace with increases in the hiring salaries of engineers.

The Conference Board also found a common belief among engineers, due to blatant "help wanted" ads and aggressive recruiting, that their company does not pay as well as others. In addition, engineers feel that merit is sometimes subordinated to seniority in determining salary increases.

Professional Discontent

Union leaders say that engineers unionized to regain the professional status they felt they lost with mass employment. Engineering societies likewise report genuine professional dissatisfaction. But they maintain it stems from the fact that many companies do not fulfill the engineer's desire to be classified as part of the management team.

As professionals, the Conference Board study points out, engineers want: (1) better communication with management in order to clarify their understanding of company policies; (2) credit in reports and papers they help develop; (3) classification as professionals rather than grouping with nonprofessionals; and (4) less frequent assignments to jobs requiring little engineering ability.

Why Individual Dissatisfaction

The disappearance of the personal relationship which once existed between engineer and employer is largely responsible for the dissatisfaction engineers now feel as individuals, according to Conference Board findings. The engineer objects to being treated on a mass basis in hiring, training, and other employment situations. He feels he has no measure of his progress such as is furnished by job titles, and no way to make his complaints known and to secure redress. In addition, he believes that he is not given sufficient training or job rotation so that he can go through the steps necessary for promotion.

Engineering Unions

In addition to covering why engineers unionize and suggestions for relieving their discontent, the Conference Board study describes the background and extent of unionization. For example, the Board notes that engineers who have joined unions belong to one of several types: (1) independent, professional unions, such as the Engineers and Scientists of America which claims 30,000 members; (2) semiprofessional unions, such as the American Federation of Technical Engineers, AFL-CIO, organized especially for engineers and others with related skills, and claiming over 15,000 members; and (3) production workers' unions, such as the United Automobile Workers, the United Steelworkers, and the International Union of Electrical Workers, all AFL-CIO. Also included in the NICB study is an analysis of provisions of engineering contracts. (The companion piece to this study is a volume listing provisions of engineering contracts.)

Solving Engineer Discontent

Engineering unions believe that unionization is the answer to engineer discontent. The argument of leaders of two principal engineering unions is set forth in the Conference Board's study.

Engineering societies disagree. What the National Society of Professional Engineers believes to be management's and the professional engineer's answer to unionization is detailed in its "checklist," which covers criteria for employers and engineers in such areas as recruitment; indoctrination; technical, administrative, professional, and personality development of the individual; and company practices. Also included in the NICB study are the recommendations of the Engineers Joint Council for raising professional standards and improving employment conditions for engineers.

Copies of the Conference Board's study may be obtained by writing for "Unionization Among American Engineers," Studies in Personnel Policy, No. 155, National Industrial Conference Board, Inc., 460 Park Avenue, New York 22, N. Y., price $2.50.

AIEE Employment Questionnaire

Returns on the AIEE 1954 Employment Questionnaire, including information on unionization, were published in *Electrical Engineering*, February 1955, pp. 96-97, and September 1955, p. 759.

Plans Made for Magnetic Amplifier Conference

The second Special Technical Conference and Exhibit on Magnetic Amplifiers will be held in Pittsburgh, Pa., at the Hotel Penn-Sheraton, September 4-6, 1957.

The conference is sponsored by the AIEE Magnetic Amplifiers Committee and the Institute of Radio Engineers (IRE) Professional Group on Industrial Electronics.

The increased interest in magnetic amplifiers was apparent at the first Conference on Magnetic Amplifiers, April 1956, held in Syracuse, N. Y., where approximately 600 persons attended the two-day conference and exhibit. Due to the large attendance expected at the 1957 conference, the length of the conference has been extended to three days.

The technical program will consist of four sessions devoted to: basic problems and techniques of design, development, manufacturing, and testing; magnetic amplifier applications; computing and switching applications of saturable magnetic devices and circuits; and a session devoted to papers of general interest which fall outside these topics. In the latter session, typical subjects might include ferrite

devices, frequency multipliers, reference devices, etc.

A number of invited papers will be presented by authorities in the field; the remainder of the program will oe made up of submitted papers. Five papers per session are planned. The deadline for submission of final manuscripts is June 11, 1957. Technical program chairman for the conference is G. F. Pittman, Jr., Westinghouse Electric Corp., P. O. Box 10596, Pittsburgh 35, Pa., Papers may be submitted for the conference only or for AIEE Transactions status as well. All papers will be published in the Conference Proceedings.

American Power Conference To Be Held March 27-29, in Chicago

THE AMERICAN POWER CONFERENCE, sponsored by The Illinois Institute of Technology in co-operation with 13 universities and 10 local and national engineering societies, including the AIEE, will be held March 27-29, 1957, at the Sherman Hotel in Chicago, Ill.

The purpose of the conference is to provide a forum for the exchange of information in the fields of power generation, transmission, distribution, and utilization.

All interested persons are cordially invited to attend. Registration and other information may be obtained from Dr. E. R. Whitehead, Secretary, American Power Conference, Illinois Institute of Technology, Chicago 16, Ill.

The tentative technical program for the conference follows.

Wednesday, March 27

9:00 a.m. Registration—Mezzanine Floor Sherman Hotel

10:00 a.m. Opening Meeting—Grand Ballroom

Chairman: Allen Van Wyck, Illinois Power Company
Cochairman: W. A. Lewis, Illinois Institute of Technology
Invocation, The Reverend I. G. Lawrence, chaplain, Illinois Institute of Technology
Similarities in the Technical Features of Nuclear Power Development in the United States and Other Countries. *Walter Zinn*, General Nuclear Engineering Corporation

12:15 p.m. American Power Conference Luncheon—Bernard Shaw Room

Sponsored by the American Society of Mechanical Engineers (ASME)
Chairman: R. S. Stover, vice-president, Region VI, ASME
Cochairman: W. H. Pletta, chairman, Chicago Section, ASME
Speaker: D. S. Kennedy, president, Edison Electric Institute and president, Oklahoma Gas and Electric Company

2:00 p.m. Central Station Steam Generators—Grand Ballroom

Chairman: H. L. Solberg, Purdue University
Cochairman: J. T. Anderson, Michigan State University
The Economic Effects of Steam Preheating Combustion Air on Air-Heater and Economizer Surfaces. *W. F. Portaline*, Foster Wheeler Corporation
Incorporating the Heat from the Stack Gases into the Supercritical Heat Cycle at Eddystone Station. *S. A. Arnow*, Philadelphia Electric Company
Operating Experiences with Twin Furnace Boilers. *E. M. Powell*, Combustion Engineering, Incorporated
Advances in the Field of Large Steam Generators. *D. R. Wilson*, The Babcock and Wilcox Company

2:00 p.m. Symposium on Extra High Voltage Systems—Louis XVI Room

Chairman: Philip Sporn, American Gas and Electric Company
Cochairman: E. T. B. Gross, Illinois Institute of Technology
Application of Extra High Voltage in France. *F. M. Cahen*, Electricitie de France, Paris, France
The 275 Kv System of the Central Electricity Authority in the United Kingdom. *F. J. Lane*, Central Electricity Authority, London, England.
The Swedish 400 Kv System. *Gunnar Jancke*, Swedish State Power Board, Stockholm, Sweden
Consideration in the Transition to Extra High Voltage Transmission. *E. C. Starr*, Bonneville Power Administration
The 345 Kv Systems of AG&E and OVEC. *F. A. Lane*, American Gas and Electric Service Corporation

2:00 p.m. Water Technology I—Assembly Room

2:00 p.m. Space Heating—Crystal Room

Chairman: J. I. Yellott, executive director, Association for Applied Solar Energy
Cochairman: Gil Freyder, Commonwealth Edison Company
The Place of the Heat Pump and Solar Energy in Space Conditioning. *R. C. Jordan*, University of Minnesota
Electric Heating in the Tennessee Valley—A Pattern for the Future. *W. R. New*, Tennessee Valley Authority
Air Conditioning with the Compound Heat Pump. *Sidney Miner*, York Corporation

8:00 p.m. Evening Forum—Bernard Shaw Room

A Forum devoted to the subject "Trends in Employment Conditions for Engineers" will be sponsored by the Engineers Joint Council and will be composed of a number of outstanding industrialists and engineers who are cognizant of the situation throughout the United States. All are invited to attend and to participate in the informal discussion which will follow the introductory remarks.

Thursday, March 28

9:00 a.m. Steam Turbines—Grand Ballroom

Chairman: Murray Joslyn, Commonwealth Edison Company
Cochairman: R. C. Porter, University of Michigan
Economics of Higher Pressures and Temperatures for Steam Turbines in Industry. *M. M. Patterson, W. B. Wilson*, General Electric Company
The Eddystone Super Pressure Turbine. *C. C. Frank*, Westinghouse Electric Corporation
Advances in the Field of Large Steam Turbines. *C. D. Wilson*, Allis-Chalmers Manufacturing Company

9:00 a.m. Water Technology II—Assembly Room

9:00 a.m. Hydroelectric Power Development—Louis XVI Room

Chairman: A. J. Ackerman, consulting engineer, Madison, Wisc.
Cochairman: D. H. Madson, State University of Iowa
Integration of Hydroelectric and Steam Power on the Pacific Gas and Electric System. *Walter Dreyer*, Pacific Gas and Electric Company
Economics of Power Generation for the TVA System. *R. A. Monroe*, Tennessee Valley Authority

9:00 a.m. Electronic Applications—Crystal Room

Sponsored by Electronics Group, Chicago Section, AIEE
Chairman: R. S. Dreffin, American Machine and Foundry Company
Cochairman: J. Roedel, chairman, Electronics Group, Chicago
Chicago Section, AIEE
Improving Radio and Television Influence of Power Lines. *F. L. Greene*, Ohio Power Company
Maintenance Problems of Electronic Equipment in New Generating Stations. *R. F. Sperlik*, Commonwealth Edison Company

10:30 a.m. Electrical Distribution—Crystal Room

Sponsored by Power Group, Chicago Section, AIEE
Chairman: L. F. Lischer, chairman, Power Group, Chicago Section, AIEE
Cochairman: E. L. Nicolson, General Electric Company
The Detroit Edison Company's Standards for Residential Underground Distribution. *E. C. DeBaene, L. J. Van Tuyl*, The Detroit Edison Company
Distribution Transformer Loading by the Load Factor Computer Method. *Perry Brittain*, Dallas Power and Light Company
Distribution Transformer Loading from Customers' Kwh Consumption. *Hugh Lawyer*, Oklahoma Gas and Electric Company

12:15 p.m. American Power Conference Luncheon—Bernard Shaw Room

Sponsored by the AIEE
Chairman: M. S. Coover, president, AIEE, Iowa State College
Cochairman: E. R. Whitehead, chairman, Chicago Section, AIEE, Illinois Institute of Technology
Speaker: The Honorable F. G. Aandahl, assistant secretary of the Interior, United States Department of the Interior, Washington, D. C.

2:00 p.m. Central Stations—Grand Ballroom

Chairman: K. M. Irwin, Philadelphia Electric Company
Cochairman: B. G. Elliott, University of Wisconsin
Turbines, Condensers and Feedwater Heaters and the Laboratories that Make Them Possible. *M. L. Machel*, Westinghouse Electric Corporation
Recent Progress in the Field of High Pressure, High Temperature Power Generation in Great Britain. *J. W. H. Dore*, Central Electricity Authority, London, England
Future of the Steam Cycle. *C. W. Elston, J. E. Owens*, General Electric Company

2:00 p.m. Electric Systems—Louis XVI Room

Chairman: Nathan Cohn, Leeds and Northrup Company
Cochairman: M. S. Helm, University of Illinois
Frequency and Load Control Problems in a Large Power System. *C. L. Karr*, Tennessee Valley Authority
Operating Experience with Area Control. *D. C. Peterson*, Northern States Power Company
Operating Experience with Dispatch Computer in Automatic Power System Control. *R. H. Travers*, Ohio Edison Company; *S. B. Yochelson*, Goodyear Aircraft
The Common Sense of Increment Loading. *L. B. Le Vesconte*, Sargent & Lundy, Engineers

2:00 p.m. Water Technology III—Assembly Room

2:00 p.m. Fuels—Crystal Room

3:30 p.m. Water Technology IV—Assembly Room

6:45 p.m. Grand Ballroom

Presiding: J. W. Evers, Commonwealth Edison Company
Entertainment: South Works Male Chorus of United States Steel Corporation, H. S. Walsh, director, Isabel N. Ebert, accompanist
Speaker: G. A. Price, Westinghouse Electric Corporation

Friday, March 29

9:00 a.m. Gas Turbines—Grand Ballroom

Chairman: P. R. Broadley, Bituminous Coal Research, Incorporated
Cochairman: W. E. Ibele, University of Minnesota

An Operator's Evaluation of the Versatile Gas Turbine. *G. H. Krapf*, United States Steel Corporation
The Mene Grande Gas Turbine Plant. *T. J. Putz*, Westinghouse Electric Corporation
Design and Characteristics of a Combined Gas and Steam Cycle for a 40,000 Kw Unit. *A. R. LeBailly, L. Skog, Jr.*, Sargent & Lundy, Engineers
Economics of Small Supercharged Plants. *E. L. Richardson*, General Electric Company; *E. L. Damin*, Foster Wheeler Corporation

9:00 a.m. Research in The Electric Power Industry—Louis XVI Room

Opportunities for Research in the Electric Utility Industry. *K. W. Miller*, Armour Research Foundation
Panel Discussion

9:00 a.m. Condenser and Feedwater Circuit —Louis XVI Room

9:00 a.m. Electrical Industrial Session—Crystal Room

Chairman: E. R. Moore, Detroit Edison Company
Cochairman: E. R. Hendrickson, Commonwealth Edison Company
The Viewpoint of the Utility Company. *C. E. Quick*, The Detroit Edison Company
The Viewpoint of the Manufacturing Company. *F. X. Doran*, Ford Motor Company

10:30 a.m. Electrical Industrial Session II—Crystal Room

Sponsored by Industrial Group, Chicago Section AIEE
Chairman: Richard Wessling, Allen-Bradley Manufacturing Company
Cochairman: J. N. Banky, Allis-Chalmers Manufacturing Company
Semi-Conductor Power Rectifiers. *L. W. Morton*, General Electric Company
Static Control—A New and Reliable Electrical System for Industry. *W. B. Weathers*, Westinghouse Electric Corporation

10:30 a.m. Digital Computers for Mechanical Problems—Louis XVI Room

Chairman: G. V. Williamson, Union Electric Company
Cochairman: R. C. King, New York University
The Use of Digital Computers for Piping Flexibility Calculations. *T. Kolflat, K. E. Knapp*, Sargent & Lundy, Engineers
Generalized Heat Balance Computation on the IBM 650 EDPM. *R. K. Large*, Detroit Edison Company; *J. E. Gerngross*, General Electric Company

12:15 p.m. American Power Conference Luncheon—Bernard Shaw Room

Sponsored by the Western Society of Engineers
Chairman: G. L. Jackson, president, Western Society of Engineers
Cochairman: H. B. Gotaas, Northwestern University
Speaker: G. M. Freeman, international president, International Brotherhood of Electrical Workers

2:00 p.m. Nuclear Energy—Grand Ballroom

Chairman: R. F. Humphreys, Armour Research Foundation
Cochairman: A. H. Barnes, Argonne National Laboratory
Inter-American Progress Toward Economic Nuclear Power. *W. F. Friend, L. F. C. Reiche*, Ebasco Services Incorporated
Significant Developments in Large Boiling Water Reactor Plants. *R. C. Freeman*, General Electric Company
Plant Design and Operating Problems of the Pennsylvania Advance Reactor. *W. E. Johnson*, Pennsylvania Advance Reactor Project
A New Approach to the Design of Containment Shells for Atomic Power Plants. *Alf Kolflat, W. A. Chittenden*, Sargent & Lundy, Engineers

2:00 p.m. Industrial Power Plants—Louis XVI Room

Chairman: F. G. Feeley, Jr., Olin Mathieson Chemical Corporation
Cochairman: C. R. Earle, executive editor, *Power Engineering*
A New Combined Steam-Gas Turbine Industrial Power Plant. *W. B. Wilson*, General Electric Company
Distribution of Steam and Electrical Power Costs in an Industrial Plant. *H. P. Kallen*, associate editor, *Power*
Incremental Efficiency Testing of Industrial Turbine Generators to Determine Steam Rates and Valve Points. *G. L. Decker*, Dow Chemical Company
Economic Dispatching of Industrial Turbine Generators by Valve Points Using a Digital Computer. *A. D. Brooks*, Dow Chemical Company

2:00 p.m. Symposium on Computers and Network Analyzers—Crystal Room

Chairman: H. L. Garbarino, Armour Research Foundation
Cochairman: J. E. Van Ness, Northwestern University
Application and Technical Uses of Digital Computers. *L. W. Swanson*, Arthur Andersen and Company
The Role of an Independent Computional Facility in Power Systems Engineering. *R. B. Wise*, Armour Research Foundation
Potential Computer Applications in a Power Company. *L. E. Jensen, T. W. Schraeder, G. P. Wilson*, Illinois Power Company
Relation of Digital and Analog Computers in the Solution of Power Systems Problems. *D. B. Breedon, R. W. Ferguson*, Westinghouse Electric Corporation

Engineers Joint Council Holds Third General Assembly

ENGINEERS JOINT COUNCIL (EJC), a federation of professional engineering societies, held its third annual General Assembly on January 17-18, 1957 at the Statler Hotel, New York, N. Y. Paramount topics discussed were the vital place and influence of the engineer, nationally in defense and internationally on the technological "cold front"; and trends in professional compensation.

At the luncheon on Thursday, January 17, Dr. J. B. Rae spoke on "The Engineer and the American Economy," and at a Friday luncheon, W. A. B. Iliff, vice-president of the World Bank, gave a talk on "Overseas Development, Engineers, and the World Bank."

EJC Unity Dinner

An EJC Unity dinner was held Thursday evening. The feature of the dinner was an address, "The Aristocracy of the Engineer," delivered by Dr. H. T. Heald, president of the Ford Foundation. In respect to scientific and engineering manpower, while not taking United States shortages and Soviet advances lightly, Dr. Heald stressed the importance of quality and the proper utilization of engineers. Unlike the medical profession, not enough basic scientific and engineering research is being done in the colleges and universities. In the address, a broad liberal education was advocated with more emphasis on graduate and postgraduate education and on research opportunities for those who have the inclination and the ability, in order that the scientist-engineer may take his proper place in society and meet international challenges. The full text of the address appears on pp. 179-181 of this issue of *Electrical Engineering*.

In the absence of Dr. T. H. Chilton, retiring president of EJC, M. D. Hooven, president of Engineers Council for Professional Development (ECPD), and past president of AIEE, presided and introduced the presidents of the various constituent socie-

Table I-A—Economic Trends from 1939-1956

Year	Consumer Index	G.N.P.	Work Force	Productivity	Weekly Payroll in Engineering
1939	59.4	91.1	45.7	2,000	29.9
1946	83.4	209.2	55.2	3,780	81.2
1952	113.5	345.4	61.1	5,650	136.6
1956	117.1	407.0	63.0	6,450	158.3

	Salaries and Wages				
		Engineers' Salaries at Various Experience Levels†			
Year	Average Weekly Wages*	Less than One Year	9-11 Years	20-24 Years	35-39 Years
1939	$0.633	$127	$259	$435	$550
1946	1.086	232	401	515	629
1952	1.670	356	549	670	670
1956	1.950	443	670	852	905

* Average weekly wages in manufacturing (dollars per hour)
† Salaries in industry. Experience measured as years from bachelors degree (dollars per month)

Table I-B—Percentage Increases for Significant Periods

	1939-46	1946-52	1952-56	1939-56
	%	%	%	%
Productivity	89	50	14	223
Consumers' Index	41	36	3	97
Median Engineers' Pay at Experience of:				
Less than one year	83	54	24	250
9-11 years	55	37	22	159
20-24 years	18	30	26	91
35-39 years	14	7	35	65
Wages	72	54	17	208

ties of EJC, affiliates and associates. Vice-president Edward Kates commended the reading of President Chilton's report and cited the growth in membership. President-elect J. W. Barker acknowledged the high responsibility of the office and promised to strive to make engineering a better profession in the free world.

Panel Discussions

Economic Status of the Engineer. The session on Thursday afternoon considered the economic status of the engineer, which included the presentation of the 1956 Salary Survey based on the earning of 110,000 engineers. Panelists included Dr. E. B. Peck who discussed "Trends in Professional Compensation"; D. P. Krotz, assistant to the president, California Research Corporation; and Frank Leamer, personnel director of Bell Telephone Laboratories. They discussed the question of position evaluation and merit rating.

Dr. Peck's paper presented an analysis of engineers' salaries from 1939 to 1956 in relation to the important economic factors: productivity, wages and consumers, costs. It proposed a framework of salary administration that takes into account the factors of experience, merit, and the economic trends. He emphasized the fact that an engineer has a professional career of 40 odd years and is, therefore, the equivalent of a large capital asset. Graphs displayed by Dr. Peck showed that the average engineer is 30 years old before he catches up in pay with the carpenter and electrician, and that it takes two and one half more years to catch up with the plumbers and bricklayers. When the pay scales represented on the graphs are integrated over a career of 43 years (age 22 to 65), the median salary of engineers exceeds the carpenters by about $80,000 and the plumbers by less than $50,000. This is not an attractive return on the investment for an engineering education, he pointed out. Table I-A shows the economic trend in salary and wages in relation to productivity during the period 1939-1956. It shows that the gross national product measured in current dollars increased more than fourfold, while the cost of living index about doubled. Wage rates increased about threefold while top management salaries increased even less than the cost of living. Most middle class salaries were squeezed between rising wages from below and a relatively static top management salary. This data is represented along with engineers' salaries for the years 1939, 1946, 1952 and 1956. For the entire period 1939-1956, the following increases took place: productivity (gross national product divided by the workers employed) increased 223% (per cent); the average hourly wage increased 208%; engineers' median salaries increased 250% for beginners, but declined with experience to 65% at 37. The older engineers' pay did not keep up with the cost of living index which increased 97%. This is shown in Table I-B.

A paper by D. P. Krotz dealt with the problem of position evaluation. This problem has come strongly to the fore because the rapid growth of technology has created large groups of engineers and scientists in industry. The nature of industry demands and the complexity and interdependence of all technology have developed the use of team effort to a large degree. Hence, the need for some kind of yardstick which permits an employer to relate the value of one man's efforts in comparison with those of other employees. There are three factors involved in position evaluation, Mr. Krotz pointed out. They are analysis, measurement, and auditing. Analysis embraces preparation of position descriptions which fully outline the assignment; measurement involves the establishment of a grading procedure for measuring the position value; and auditing is the co-ordination of the analysis and measurement steps by an impartial agency established to check, counsel, and guide the supervisors.

Frank Leamer's talk on merit ratings stressed that there is no one best technique clearly superior to all others for evaluating relative worth of professional technical personnel. It is possible, however, to evaluate relative worth by means of quantitative multiple judgments of relative overall contribution or performance. Performance ratings should be separated from salary adjustment. Each individual's performance rating should be independent of a prior rating and should be made without reference to present salary position. Relating performance ratings to appropriate salary position, he pointed out, is a gradual and somewhat arbitrary judgmental process that is aided by having a family of salary guide curves which are designed to divide the technical population into proportional parts (octiles, quartiles, etc.) at levels established as a part of salary administration policy. Performance ratings, in addition to providing a sound basis for rate review consideration, also require that supervisors improve their competence in appraising the contributions and characteristics of individuals.

Engineer in International Relations. C. P. Dunn's paper pointed out some of the important differences between foreign engineering activities and the domestic situation. There is the fact that a United States engineer working overseas is regarded as a representative of the United States Government. Complete co-operation with the people of the State Department and related agencies is essential and desirable. There is also the fact that many foreign engineers demand too much of themselves and seem to expect that they must learn in one year the things that an American has taken many years to learn. He is forced to request help of the American engineer although disliking to do so. Remarks have been heard such as: "Surely we need your help. We need your money and your skill—but isn't there some way you can help us without making us listen to the constant repetition of the phrase 'great American know-how'?"

EJC Officers

J. W. Barker, ASME, and F. S. Black, AIEE, unanimously were elected president and vice-president of EJC for 1957 at the Board Meeting, November 16, 1956. Continuing officers are: E. P. Lange, secretary; E. L. Chandler, treasurer; and L. K. Wheelock, assistant secretary. The installation took place at the close of the General Assembly.

Technical Conference To Be Held in Washington, D.C., April 22-23

A special technical conference sponsored by the Joint AIEE-Institute of Radio Engineers (IRE) Committee on Solid-State Devices and the department of electrical engineering of the Catholic University of America will be held on Easter Monday and Tuesday, April 22 and 23, 1957, in Washington, D. C., on the Catholic University campus.

The program will consist of four half-day technical sessions and one evening meeting with the Washington Section of the AIEE. The first technical session will consist of a group of invited papers by guest speakers who are well-known authorities in their respective fields. The other three sessions will be composed of papers chosen from those submitted to the conference technical program chairman.

The papers will include solid-state device and material developments in the fields of dielectrics, ferroelectrics, and ferrites, with special emphasis on bridging the gap between the research effort in the basic sciences and use areas exemplified by specific end products.

The advance registration fee has been set at $4, with registration available at the door for $5.

Any inquiries concerning this conference can be addressed to: Prof. J. C. Michalowicz, Electrical Engineering Department, Catholic University of America, Washington, D. C.

Management Conference Being Held in Pittsburgh, Pa.

The General Arrangements Committee for the Management Division Conference met at the Engineers Society of Western Pennsylvania, Pittsburgh, Pa., December 7, 1956, to complete preliminary plans for the 1957 Management Conference to be held in the Penn-Sheraton Hotel, March 27-28.

The conference, sponsored by the AIEE and the American Society of Mechanical Engineers (ASME), is under the direction of Charles Jurgensen, chairman of the Management Division of ASME. It will be devoted to engineering management controls. The preliminary program calls for sessions on control through organization, control through management development, control through electronic data processing, and control of engineering effort in research and development. The conference is expected to attract many technical and business leaders.

The tentative technical program for the Engineering Management Conference follows:

Wednesday, March 27

10:00 a.m. Control through Organization

Control of the Engineering Function in a Decentralized Company. *G. F. Habach,* Worthington Corporation

Planning and Scheduling the Engineering Work Load for Maximum Utilization of Engineering Staff. *F. H. Meyer,* Methods Engineering Council

Courtesy Associated Photographers

MEMBERS of the General Arrangements Committee for the AIEE-ASME Management Division Conference are: (*seated, left to right*) V. B. Baker, AIEE, chairman, Reception Committee; H. R. Fulton, chairman of the Pittsburgh Section; H. B. Kiphuth, AIEE, vice-chairman of the Conference Committee; D. E. Farr, ASME, chairman, General Arrangements Committee; Prof. D. W. Ver Planck, ASME, vice-chairman, General Arrangements Committee; Charles Punton, ASME, chairman, Registration Committee; (*standing, left to right*) J. R. Aikins, ASME, chairman, Publicity Committee; Lee Tarn, AIEE, vice-chairman, Publicity Committee; A. L. Bayles, ASME, vice-chairman, Reception Committee; H. L. Shakeshaft, ASME, vice-chairman, Hotel and Entertainment Committee; P. A. Beckjord, AIEE, chairman, Hotel and Entertainment Committee; and E. W. Brewer, AIEE, vice-chairman, Registration Committee. Other members, unable to attend the Committee meeting, are Charles Jurgensen, ASME, chairman, Conference Committee; K. F. Treschow, ASME, chairman, Finance Committee; and W. R. Harris, AIEE, vice-chairman, Finance Committee.

Luncheon

Speaker: J. A. Hutcheson, vice-president of engineering and research, Westinghouse Electric Corporation

Afternoon Session—Control through Management Development

Developing Engineers for Management. *H. B. Kiphuth*, Westinghouse Electric Corporation
Tailoring a Training Program to Company Needs. *C. A. Jurgensen*, De Laval Steam Turbine Company
Development of Engineering Managers through Planned Education and Training. *Melvin Anshen*, Carnegie Institute of Technology

Dinner

Speaker: W. F. Ryan, president, American Society of Mechanical Engineers

Thursday, March 28

9:00 a.m. Control through Electronic Data Processing

What the Engineer Can Do with Data Processing Equipment. *C. R. DeCarlo*, International Business Machines Company
Production and Inventory Control with Electronic Equipment. *E. S. MacMichael*, United States Steel Corporation
Control of Design and Engineering Procedure through Electronic Data Processing Equipment. Group presentation by General Electric Company, *D. H. Ware, W. J. Martiny, Frank Maginniss*

Luncheon

Standardization—An Aid to Management, *H. T. Hallowell, Jr.*, president, Standard Pressed Steel Company, president, American Standards Association

Afternoon Session—Control of Engineering Effort in Research and Development

Where and How Should Your Research Dollars Be Spent. *P. W. Bachman*, Koppers Company
Control of Research and Development Effort To Meet Company Objectives. *Aaron Wexler*, Westinghouse Research Laboratory

AIEE Summer General Meeting To Be Held in Montreal, Canada

The site for the 1957 AIEE Summer General Meeting is to be Montreal, Que., Canada. Headquarters for the meeting will be the Sheraton-Mount Royal Hotel. It is anticipated that more than the members and guests who attended last year's meeting will take advantage of the beautiful vacation locale of this meeting from June 24 through June 28.

The various Committees have scheduled interesting programs for the members and their guests with visits to points of interest in the vicinity, such as the top of Mount Royal, and the Bersimis I powerhouse on the north shore of the St. Lawrence River.

Hotel accommodations have been arranged, and delegates will be able to make reservations either at the headquarters hotel or one of the others, all of which are within two blocks of each other.

IMPORTANT: All requests for hotel reservations MUST be sent to:

The Montreal Tourist & Convention Bureau
Suite M. 30
1455 Peel Street
Montreal 2, Que., Canada

They must not *be sent to the hotel.*

Requests for reservations will be handled and confirmed in the order in which they are received—first come, first served. Please mail your application WITHOUT DELAY, inasmuch as the closing date for making reservations is May 24, 1957.

Hotel	Single Room	Double or Twin Bed Room	Suites
Sheraton-Mount Royal	$9.50	$11.85 to $16.50	$26 up
Laurentien	$9.85	$11.50 up	—
Windsor	$9.00	$12.00 up	$21 up
Queen's	$8.00	$12.00 up	—

The minimum rate for the accommodations requested will apply if still available. When not available, the next lowest rate will be applied. Confirmed reservations will be held by the hotel until 6 p.m. of the arrival date, after which they will be cancelled unless the hotel is otherwise notified by the delayed guest.

One of the inspection trips will be a tour of the Bersimis I powerhouse which generates electricity for the area and which is part of a gigantic development undertaken by the Quebec Hydro-Electric Commission in the wilderness of the north shore of the St. Lawrence River. This powerhouse is now supplying Montreal with electricity. Although this source of energy is located some 400 miles away from this great Canadian metropolis, power is available for use in Montreal within a split second of its production inside the vast underground powerhouse which has an installed capacity that will attain 1.2 million hp, once its eight generating units are in place. Three generating units of 150,000 hp apiece are in operation at present. The remaining units will be added to the far-flung Quebec Hydro-Electric Commission system within the next 18 months.

Meeting Held by Council of Engineering Society Secretaries

A three-day meeting of the Council of Engineering Society Secretaries and members of their staffs was held at the Hotel Statler, New York, N.Y., January 14-16, 1957. Views were freely exchanged on a wide variety of problems in connection with society operation which will enable the various societies to better serve their members.

On the business side, such important subjects as sources of society income, investments and insurance programs, and billings and records were considered. Another panel discussed the problems of membership campaigns, collection of dues in arrears, removals and reinstatements, as well as convention program planning by staffs of committees.

The sessions on the last day were devoted to publishing costs, readership surveys, and the ratios of editorial content to advertising.

Several methods of printing or duplication and the various costs of different methods were explained and illustrated by S. A. Tucker (ASME). Magazine printing costs were analyzed by three representatives of the Mack Printing Company. H. F. Hutchison, vice-president, outlined the methods of cost accounting in a printing plant and

AIEE Members Tour CNT Facilities

CANADIAN NATIONAL TELEGRAPHS (CNT) guide C. L. Crandell (*right*) explains switchboard procedures to members of the AIEE Toronto executive council during the Institute's tour of CNT's Toronto facilities January 10. The tour, which included 150 AIEE members and their guests, was conducted throughout the CNT facilities in the new communications center. Shown during the tour are (*left to right*) R. M. Clark, CNT, Prof. G. F. Tracy, R. J. Brown, W. E. Crooks, G. M. Frazer, R. L. Hicks, R. B. Steele, J. C. Burkholder, J. T. Fisher, V. B. Ross, P. O. Smith, and E. A. Ricker.

the allocations of overhead. J. J. Green illustrated the comparative efficiencies of three different sizes of format and H. L. Varley outlined the essentials of good typography, with type faces for headings, text, and other related matter in harmony. Procedures for preparing good clear copy with a view toward avoiding authors' alterations and reduction in cost of composition also were explained.

Newly elected officers were as follows: President L. A. Wright, general secretary, Engineering Institute of Canada; Vice-President A. R. Putnam, assistant executive secretary, American Society of Tool Engineers; Secretary N. S. Hibshman, secretary, AIEE; Treasurer W. P. Youngclaus, executive secretary, American Society for Quality Control; and Directors C. S. Doerr, executive secretary, The Engineers' Club of Philadelphia; W. H. Evans, executive secretary, Engineers' Society of Milwaukee; and Colin Campbell, Society of Geophysicists.

San Francisco Section Meeting

AT THE JANUARY general meeting of the San Francisco Section of the AIEE, a panel described what the coming decade holds for utility companies. Meeting after the discussion are: (*left to right*) W. G. Collins, chairman of the Section; and panelists J. K. Horton, vice-president, Pacific Gas & Electric Company; H. L. Kertz, vice-president for construction and engineering, Pacific Telephone & Telegraph Company; and L. E. Hoyt, assistant to the general manager, The Southern Pacific Company.

Dr. De Forest Honored at Opening of New Laboratory

About 50 individuals whose active interest in electronics goes back to its very first days, gathered at the opening of the new Palo Alto, Calif., facility of Federal Telecommunication Laboratories on December 15, 1956, to render special homage to Dr. Lee de Forest (F '18), who was the guest of honor. The new laboratory, under the direction of W. S. Chaskin, is set up to do research and development work on carrier and other advanced telephone communication apparatus—equipment which will be manufactured by other units in the IT&T (International Telephone & Telegraph) family.

The reunion and open house which signaled the beginning of operations with a staff nucleus of 14 individuals had a double historical significance—recognition of the 50th anniversary of Dr. De Forest's invention of the three-element electron tube in 1906; and the return of Federal to Palo Alto, the city where De Forest, together with his colleagues, C. V. Lockwood and Herbert Van Etten, working in the original Federal laboratory, constructed the first successful audio amplifier and discovered the principles of feedback oscillation in the year 1912. It is on these foundations that the entire electronics industry has been built.

Iowa-Illinois Section Visits Cellophane Plant

Fifty-four electrical engineers from the Iowa-Illinois Section of the AIEE inspected the Cellophane Plant of E. I. du Pont de Nemours & Co. (Inc.) at Clinton, Iowa, on November 20, 1956.

J. F. Gassman, electrical supervisor at the Cellophane Plant, gave a brief description of the growth of the Du Pont Company and with the aid of diagrams explained the process used to manufacture cellophane.

Following this, the engineers were taken on a tour of the plant which started with the power house. Then, the manufacturing process was followed from the fifth floor, beginning with sulfite wood pulp, down to the casting machines on the first floor, where the cellophane becomes a sheet. From there, it goes to the coating tower to be given special coatings and then is cut to size in the slitting area. Souvenir samples of cellophane were distributed at the completion of the tour.

The Iowa–Illinois Section, comprising 11 Iowa counties and 5 Illinois counties, represents a majority of the Mississippi Valley area between Dubuque and Keokuk, Iowa.

Victoria Section Formed

Courtesy G. N. Y. Simpson

A DINNER MEETING was held on December 4, 1956, to celebrate the formation of the Victoria Section of the AIEE (formerly the Vancouver Island Subsection). Some of those in attendance were (*seated in front, left to right*) A. F. Thommasen, chairman; M. M. Ewell, vice-president, District 9; (*back row, left to right*) O. B. Bass, first vice-chairman and chairman of Papers Committee; H. A. Ashton, secretary-treasurer; and J. D. Taylor, second vice-chairman in charge of Membership Committee. A Subsection was first formed on Vancouver Island in 1950 which grew steadily in membership until application was made in 1956 for section status. Approval was granted on October 5, 1956, by the National Board of Directors. This is the 110th Section of the Institute.

Los Angeles Section Names Electrical Engineer of the Year

W. S. Peterson (F '46), general manager and chief engineer of the Los Angeles Department of Water & Power, was named "Electrical Engineer of the Year" by the Executive Committee of the Los Angeles Section of the AIEE.

Mr. Peterson was born in Anaconda, Mont. He graduated from the University of California in 1917 with a degree in electrical engineering. In 1922, he joined the Los Angeles Department of Water & Power as a mechanical electrical draftsman, having previously worked for the General Electric Company's testing department and for the Anaconda Mining Corporation.

W. S. Peterson

Mr. Peterson is best known for work he has done in connection with the Boulder Dam Transmission Lines. Following the completion of the Boulder Dam Transmission Lines, Mr. Peterson was assigned the duties of technical administrative assistant to the chief electrical engineer, and represented the Department of Water & Power in Washington, D. C., during the early years of World War II. He was also a power consultant to the War Production Board.

In December 1943, Mr. Peterson was appointed to head the Power Systems Design and Construction Division, and in 1945 became assistant chief electrical engineer of the department. Following this position he served as a consultant to the National Security Resources Board. In November of 1951, he was appointed chief electrical engineer and assistant manager, and on April 1, 1953, he became assistant general manager and chief engineer. He was appointed to his present position on October 1, 1955.

Mr. Peterson is the author and coauthor of many technical papers for the AIEE. He served as chairman of the Los Angeles Section, 1955-56. In 1955 and 1956, he was the vice-president of the American Public Power Association, and vice-chairman of that association's Atomic Power Policy Committee. Currently, he is president of the American Public Power Association.

Melville Eastham Receives Armstrong Medal

The Armstrong Medal of The Radio Club of America was awarded at the club's 47th Anniversary Banquet to Melville Eastham (F '46) ". . . in recognition of his outstanding contributions to the art of precision measurements in the radio and electronic field." The citation continued:

"For fifty years a design engineer, Mr. Eastham's effort made available to many workers in the electronic art reliable test equipment of a standardized nature which previously did not exist or had to be specially assembled as a laboratory setup.

"Beside his many technical contributions, Mr. Eastham was a leader in recognizing the importance of good employee relations, and assisted and encouraged his associates in continuing their technical education and in making contributions to technical literature. His thorough, practical approach to design problems and his enlightened management practices should be an inspiration to younger men."

Mr. Eastham was the founder of the General Radio Company, Cambridge, Mass., and now holds the title of honorary president. He was president of the firm from 1915 to 1944, and chief engineer from 1915 to 1950.

He is a Fellow of the Institute of Radio Engineers and the American Association for the Advancement of Science, and a member of the Acoustical Society of America, American Physical Society, and American Meteorological Society.

Membership in the American Institute of Electrical Engineers, including a subscription to this publication, is open to most electrical engineers. Complete information as to the membership grades, qualifications, and fees may be obtained from Mr. N. S. Hibshman, Secretary, 33 West 39th Street, New York 18, N. Y.

Official Nominees Announced for 1957 AIEE National Election

At its meeting held January 21, 1957, the AIEE Nominating Committee selected the following official nominees for election to Institute offices for terms beginning August 1, 1957:

W. J. Barrett, transmission maintenance engineer with the New Jersey Bell Telephone Co., Newark, N. J., was nominated for the position of 1957-58 AIEE President. Nominations were also made:

For Vice-Presidents:

B. R. Teare, Jr., dean of engineering & science, Carnegie Institute of Technology, Pittsburgh, Pa. (District #2)

H. W. Oetinger, executive assistant, Duke Power Co., Charlotte, N.C. (District #4)

A. G. Johnson, chief engineer, Omaha Public Power District, Omaha, Nebr. (District #6)

O. A. Gustafson, installation & service engineering, Pacific-Northwest District, General Electric Company, San Francisco, Calif. (District #8)

G. F. Tracy, head of electrical engineering department, University of Toronto, Toronto, Ont., Canada (District #10)

For Directors:

W. R. Clark, chief engineer, product engi-

neering department, Leeds & Northrup Co., Philadelphia, Pa.

E. W. Morris, engineering and service engineering manager, Westinghouse Electric Corp., Los Angeles, Calif.

J. C. Strasbourger, general supervisor mechanical buying, The Cleveland Electric Illuminating Co., Cleveland, Ohio.

Nominated for Treasurer:

L. F. Hickernell, chief engineer, Anaconda Wire & Cable Company, Hastings on Hudson, N.Y.

These nominations were announced at the General Session by W. R. Brownlee, chairman of the Nominating Committee.

The Nominating Committee, in accordance with the Constitution and Bylaws, consists of 20 members: 1 selected by the executive committee of each of the 10 geographical Districts, 1 selected by each of the 5 technical divisions, and 5 selected by the Board of Directors from its own membership.

The Constitution and Bylaws of the Institute require publication in *Electrical Engineering* of the nominations made by the Nominating Committee. Provision is made for independent nominations as indicated in the following excerpts from the Constitution and Bylaws:

Constitution: C33. Independent nominations may be made by a petition of twenty-five (25) or more corporate members sent to the Secretary when and as provided in the Bylaws; such petitions for the nomination of Vice-Presidents shall be signed only by members within the District concerned.

Bylaws: B28. Petitions proposing the names of candidates as independent nominations for the various offices to be filled at the ensuing election, in accordance with C33 (Constitution), must be received by the secretary of the Nominating Committee not later than March 15 of each year, to be placed before that committee for the inclusion in the ballot of such candidates as are eligible.

On the ballot prepared by the Nominating Committee in accordance with the Constitution and sent by the secretary to all qualified voters on or before April 15 of each year, the names of the candidates shall be grouped alphabetically under the name of the office for which each is a candidate.

A list of members of the Nominating Committee appeated in the January issue of *Electrical Engineering*, p. 82.

To enable those Institute members not acquainted personally with the nominees to learn something about their engineering careers and their qualifications for the Institute offices to which they have been nominated, brief biographic sketches are scheduled for inclusion in the "AIEE Personalities" columns of the April issue.

It was pointed out by Chairman Brownlee that petitions proposing the names of candidates as independent nominations for the various offices to be filled at the ensuing elections be made in accordance with the AIEE Constitution. These should be in the hands of the secretary of the Nominating Committee not later than March 15, 1957, in order to be included on the ballot if candidates are deemed eligible.

COMMITTEE ACTIVITIES

EDITOR'S NOTE: *This department has been created for the convenience of the various AIEE technical committees and will include brief news reports of committee activities. Items for this department, which should be as short as possible, should be forwarded to R. S. Gardner at AIEE Headquarters, 33 West 39th Street, New York 18, N. Y.*

Power Division

Committee on Relays (W. K. Sonnemann, *Chairman;* R. A. Larner, *Vice-Chairman;* J. L. Blackburn, *Secretary*). The Relay Committee operates with 12 Subcommittees, each actively engaged in some phase of its assigned work. Of particular interest to all relay engineers will be a planned report of the Survey of Relaying Practices Subcommittee, under the chairmanship of R. A. Larner.

This Subcommittee is making a survey with the intention of bringing out not only the present day relaying practices in use in the United States and in Canada, but also the trends in this fast-moving phase of the industry.

Included in the survey, of course, will be the relay protection of the basic system elements such as generators, transformers, transmission lines, etc. Of equal importance will be the treatment of various general subjects, some of which have greatly increased in importance in the past decade. Some of these subjects are "Industrial Interconnections," "Multiterminal Lines," "Out-of-Step Protection," "Reclosing Practices," and "Remote Tripping Schemes."

The work of the Subcommittee is considerably dependent upon procuring information through the medium of questionnaires, which takes time. However, it is expected that the report will be available late in 1957.

AIEE PERSONALITIES

T. C. Fry (F '50), retired, has been appointed senior consultant for Remington Rand Univac. In his new position, he will serve in a consulting capacity to all organizations of the Univac Division. Dr. Fry graduated from Findlay College in 1912 and later studied and taught at the University of Wisconsin where he received a Ph.D. degree in mathematics in 1920. He also has lectured at the Massachusetts Institute of Technology and Princeton University. Prior to joining Remington Rand Univac, he had been associated with the Bell Telephone system for more than 40 years. At the time of his recent retirement, he was assistant to the president of the Bell Laboratories. In scientific circles, Dr. Fry is best known as an expert on the mathematical theory of probability and especially its application to various communication problems. He is the author of a book on this subject, "Probability and Its Engineering Uses." He has been awarded the Presidential Certificate of Merit for his work during World War II as a member of the Fire Control Division of the National Defense Research Committee and deputy chief of its applied mathematical panel. Dr. Fry is a fellow of the American Physical Society and the Institute of Mathematical Statistics. He had been a vice-president of the American Mathematical Society and the Mathematical Association of America.

D. I. Bohn (AM '23, F '49), manager of special electrical development engineering, has retired from Aluminum Company of America after more than 34 years of service. Mr. Bohn received his degree in electrical engineering from the University of Wisconsin, and joined Alcoa in 1923 as assistant electrical superintendent at the company's Badin, N. C., works. Two years later he became electrical superintendent, and, in 1928, transferred to Alcoa's home office in Pittsburgh, Pa., as assistant chief engineer. He was named chief electrical engineer in 1946, a position he held until 1953 when he assumed the duties from which he is retiring. During his career with Alcoa, Mr. Bohn obtained over 15 patents in the electrical field, covering developments in protection devices, accessories, current converting systems, and welding apparatus. He also has written numerous authoritative engineering articles. One of Mr. Bohn's important contributions to the aluminum industry, and to the power industry in general, was his development of innovations in gas engine design which resulted in the adoption of the radial gas engine as a source of industrial power. Other achievements by Mr. Bohn include improvements in metal rolling equipment and his development of the first totally enclosed air-conditioned crane cab. In recognition of his many contributions to engineering, Mr. Bohn received the Lamme Gold Medal from the AIEE in 1950.

L. R. Keiffer (AM '22, M '32), consulting electrical engineer, is retiring after 37½ years with the lamp department, General Electric Co., Nela Park, Cleveland, Ohio. He graduated in 1919 from the University of Illinois. Mr. Keiffer has had an active part in the development and promotion of the use of fluorescent lamps and is a specialist on their performance and operation.

D. C. Mills (AM '54), senior design engineer on magnetic air circuit breakers for the Pacific Switchgear Division, Federal Pacific Electric Company, has been named manager of development engineering for the Eastern Switchgear Division. A graduate of Stanford University, Mr. Mills joined the Federal Pacific staff as a project engineer in the Santa Clara, Calif., plant in 1949. In 1953, he was promoted to senior design engineer for the Pacific Switchgear Division in San Francisco, Calif. He is a member of Tau Beta Pi, Phi Beta Kappa, and the Professional Engineering Society of California.

J. B. Epperson (M '50), chief engineer, Scripps-Howard Radio, Inc., Cleveland, Ohio, has been elected to the position of vice-president for engineering. Mr. Epperson will be in charge of engineering for all Scripps-Howard radio and television properties across the country, but will remain in Cleveland with Station WEWS as his base of operations. He has been associated with Scripps-Howard Radio, Inc., for more than 21 years, except for a leave of absence during World War II when he served with the War Department as consultant to the Chief Signal Officer on matters of radar and communications. A veteran of television engineering and author of many technical papers, Mr. Epperson went to Cleveland more than 10 years ago to help supervise construction of WEWS and serve as its chief engineer. In 1946, he became chief engineer for the Scripps-Howard Stations. Mr. Epperson has served on the following AIEE Committees: Television and Aural Broadcasting (1952-57, chairman 1954-56); and Communication Division (1954-56).

OBITUARIES

Edmund P. Coles (AM '95, M '30, F '35), retired, died recently in Charlotte, N. C. Mr. Coles was born in Buckingham County, Va., April 1, 1873. He was a graduate of Washington and Lee University. Mr. Coles was associated with the General Electric Company for 47 years. At the time of his retirement in April 1943, he was manager, Charlotte, N. C., Office, Apparatus Sales Division, General Electric Company. During his long residence in Charlotte, he was a member of the Mercy Hospital Board, Charlotte Rotary Club, North Carolina Society of Engineers, and Charlotte Engineers Club, of which he was president in 1928. Mr. Coles served on the AIEE Membership Committee (1930-35).

Winder Elwell Goldsborough (AM '93, M '99, F '12, Member for Life), consulting engineer and former director of the Purdue University School of Electrical Engineering, Lafayette, Ind., died recently, at the age of 85. Mr. Goldsborough taught at the University of Arkansas where he was made professor of electrical engineering. In 1894, he joined the staff of Purdue University. From 1896 to 1905, he served as director of the Purdue School of Electrical Engineering. He was head of the research department of Henry L. Doherty & Co., New York, N. Y., from 1923 to 1932. After 1939, he was a consulting engineer and economist until his retirement.

Harold Grant Mathewson (AM '31, M '42, F '49), building and equipment engineer for Southwestern Bell Telephone Company in Texas, died recently. Mr. Mathewson was born in Chicago, Ill., on May 26, 1897. He served in the U. S. Navy during World War I, and studied mechanical engineering at Rice Institute for three years. He was engaged by Southwestern Bell as a student engineer in Dallas, Tex., on August 17, 1920, and later the same year became specification engineer. In 1924, he was transferred to the St. Louis, Mo., headquarters of the company as program study engineer, and returned to Dallas as plant extension engineer in 1927. Mr. Mathewson was made building and equipment engineer for the Texas area of the company on October 1, 1937, the position he held at the time of his death. Mr. Mathewson had served as chairman of the North Texas Section of the AIEE. Also he was active in the Dallas Electric Club. He served on the AIEE Committee on Communication Switching Systems (1954-56).

MEMBERSHIP

Recommended for Transfer

The Board of Examiners at its meeting of January 17, 1957, recommended the following applications for transfer. Any objections to these transfers should be filed at once with the secretary of the Institute. A statement of valid reasons for such objections must be furnished and will be treated as confidential.

To Grade of Member

Abel, G. C., chief electrical engineer, USAF, Norton AFB, San Bernardino, Calif.
Akins, H. C., elec. & mech. facilities engr., General Electric Co., Ballston Spa, N.Y.
Allen, J. E., supervisory engineer, Air Arm Div., Westinghouse Electric Corp., Baltimore, Md.
Axelby, G. S., project engineer, Westinghouse Electric Corp., Baltimore, Md.
Baum, W. U., electrical planning engineer, Pennsylvania Power & Light Co., Allentown, Pa.
Bell, J. E., section manager, Westinghouse Electric Corp., Lima, Ohio.
Bernstein, T., instructor, elec. engg. dept., University of Wisconsin, Madison, Wis.
Cable, A. P., design commissioning, Ewbank & Partners (Canada) Ltd., Toronto, Ont., Canada.
Carlson, F. L., supervisor, property records dept., Dairyland Power Co-operative, LaCrosse, Wis.
Chambers, W. R., assistant electrical supt., Montana Dakota Utilities Co., Mobridge, S. Dak.
Chester, J. E., engineer, Pacific Tel. & Tel. Co., Sacramento, Calif.
Chester, P. F., utilities engineer, Timken Roller Bearing Co., Canton, Ohio.
Coon, G. M., president, Hutco Electric, Inc., Cleveland, Ohio.
Cruess, W. F., manager, supervisory control engineer, Westinghouse Electric Corp., East Pittsburgh, Pa.
Dickman, G. J., electrical engineer, Bechtel Corp., San Francisco, Calif.
Doty, C. R., senior development engineer, International Business Machines, Poughkeepsie, N.Y.
Duff, J. R., manager, machinery electrification sales, Westinghouse Electric Corp., St. Louis, Mo.
Fay, J. G., electrical engineer, Air Arm Div., Westinghouse Electric Corp., Baltimore, Md.
Fox, H. F., test engineer, Dayton Power & Light Co., Dayton, Ohio.
Gilcrest, G. R., electrical engineer, Missouri Public Service Commission, Jefferson City, Mo.
Griffin, R. C., asst. supervisor, mechanical testing, Pennsylvania Power & Light Co., Hazleton, Pa.
Henderson, F. L., field engineer, General Electric Co., Philadelphia, Pa.
Herter, T. J., product engineer, Westinghouse Electric Corp., East Pittsburgh, Pa.
Heyman, L. H., statistician, Memphis Light, Gas & Water Div., Memphis, Tenn.
Hochdorf, M., mathematician, Tennessee Valley Authority, Chattanooga, Tenn.
Hockenjos, R. M., engineer, New York Telephone Co., Bronx, N.Y.
Horton, F. W., district manager, Minneapolis-Honeywell Regulator Co., Shreveport, La.
Kallop, A. M., sales engineer, General Electric Co., Reading, Pa.
Ketner, M. H., industrial engineer, Metropolitan Edison Co., Reading, Pa.
Keyser, A. R., supervisor of communication, Gulf Power Co., Pensacola, Fla.
Kim, C. J., chief, load dispatch sec., Korea Electric Power Co., Seoul, Korea.
Koerber, A. R., proposition engineer, General Electric Co., Pittsfield, Mass.
LeBosquet, R. J., planning engineer, Wisconsin Power & Light Co., Madison, Wis.
Lynn, G. E., engineer, Westinghouse Electric Corp., Baltimore, Md.
Martt, E. C., engineer, Lamp Div., General Electric Co., East Cleveland, Ohio.
McCourt, A. W., manager, development engineer, Air Arm Div., Westinghouse Electric Corp., Baltimore, Md.
McDonnel, F. A., production engineer, General Electric Co., Pittsfield, Mass.
McDonough, J. T., senior engineer, Air Arm Div., Westinghouse Electric Corp., Baltimore, Md.
McLemore, G. R., chief system operator, Southwestern Gas & Electric Co., Shreveport, La.
Noble, D. H., electrical engineer, Central of Georgia Railway Co., Savannah, Ga.
Otto, W. B., electrical engineer, Fluor Corp., Ltd., Los Angeles, Calif.
Pearson, C. W., engineer, General Electric Co., East Cleveland, Ohio.
Plengey, W. D., engineer, Union Carbide Nuclear Co., Oak Ridge, Tenn.
Pope, M., partner, Pope & Evans, 21 E. 40th St., New York, N.Y.
Radnor, R. R., heat transfermer engineer, General Electric Co., West Lynn, Mass.
Randolph, A. M., electronics engineer, research dept., United Gas Corp., Shreveport, La.
Reiff, L. S., project engineer, Metropolitan Edison Co., Reading, Pa.
Reps., D. N., distribution engineer, Westinghouse Electric Corp., East Pittsburgh, Pa.
Rollins, F. F., asst. genl. foreman, meter dept., Niagara Mohawk Power Co., Niagara Falls, N.Y.
Schoeler, C. J., asst. chief electrical engineer, A. Epstein & Sons, Inc., Chicago, Ill.
Schwerdtfeger, W. J., electrical engineer, National Bureau of Standards, Washington, D.C.
Simmons, A. J., design engineer, Philadelphia Electric Co., Philadelphia, Pa.
Singler, J. B., electrical engineer, Sargent & Lundy, Chicago, Ill.
Stauffer, F. E., project engineer, Metropolitan Edison Co., Reading, Pa.
Stoudenmire, J. H., senior electrical engineer, Friez Instr. Div., Bendix Corp., Baltimore, Md.
Stuart, J. W., systems engineer, Westinghouse Electric Corp., Pittsburgh, Pa.
Swickard, E. O., Jr., staff member, Los Alamos Scientific Laboratory, Los Alamos, N.M.
Tennant, O. A., sales engineer, Westinghouse Electric Corp., Des Moines, Ia.
Turkal, G., engineering specialist, Goodyear Aircraft Corp., Akron, Ohio.
Van den Honert, L., supervisor, apparatus transformer engg., General Electric Co., Pittsfield, Mass.
Van Ness, J. E., associate professor of electrical engg., Northwestern University, Evanston, Ill.
Vickery, A. E., field engineer, General Electric Co., Houston, Texas.
Warner, E. J., applications engineer, Production Research Corp., Thornwood, N.Y.
Washburn, I. W., assistant engineer, Potomac Electric Power Co., Washington, D.C.
Woerner, F. R., power sales engineer, Texas Electric Service Co., Fort Worth, Texas.
Young, C., electrical engineer, Irby Seay Co. (consultants), Memphis, Tenn.

66 to grade of Member.

Applications for Election

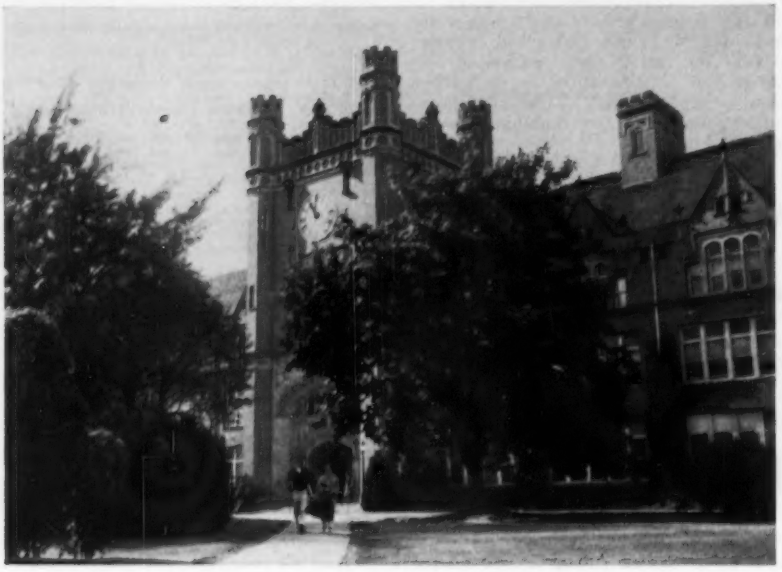
Applications for admission or re-election to Institute membership in the grade of Member have been received from the following candidates, and any member objecting to election should so notify the Secretary before March 25, 1957, or May 25, 1957, if the applicant resides outside of the United States, Canada, or Mexico.

To Grade of Member

Arnold, J. B., manager-carrier & radio sales, Automatic Electric Sale Co., Chicago, Ill.
Bailey, G. G., superintendent, line construction, Commonwealth Edison Co., Maywood, Ill.
Bateman, L. A., senior engineer, Manitoba Hydro-Electric Board, Winnipeg, Manitoba, Canada.
Bjornson, N. R., chief electrical engineer, Atomic Energy Division, Giffels & Vallet Inc., Detroit, Mich.
Bullock, M. W., engineering manager, Continental Electronics Mfg. Co., Dallas, Tex.
Cassell, G. J., supervisor, Long Island Lighting Co., Mineola, N.Y.
Chambers, J. O., vice-president, West Penn Power Co., Greensburg, Pa.
Cordle, T. L., head, electrical dept., J. N. Pease & Co., Charlotte, N.C.
Corey, H. E., Jr., transmission maintenance & co-ordination engineer, American Tel. & Tel. Co., New York, N.Y.
Coventry, A. F., overseas technical sales manager, B.I.C.C., London, England.
Elsom, F. H., supervising electrical engineer, U.S. Engineers, Savannah, Ga.
Hallstrom, L. E., plant extension engineer, The Bell Telephone Company of Pennsylvania, Philadelphia, Pa.
Hebert, J. A., Louisiana outside plant engineer, Southern Bell Tel. & Tel. Co., New Orleans, La.
Hertz, L. M., manager-advance product engineering, General Electric Co., miniature lamp dept., East Cleveland, Ohio.
Kressly, H. A., chief electrical engineer, Grumman Aircraft Engineering Corp., Bethpage, N.Y.
Laudel, A., Jr., sr. research electrical engineer, Midwest Research Institute, Kansas City, Mo.
Liquin, F. B., president, Associated Engineers, Inc., Billings, Mont.
Miller, C. B., Jr., assistant supervisor of branches, Duke Power Co., Charlotte, N.C.
Rost, H. O., chief development engineer, Jefferson Electric Co., Bellwood, Ill.
Thayer, G. N., chief engineer, American Tel. & Tel. Co., New York, N.Y.
Toler, W. R., Jr., electrical engineer, Arkansas Power & Light Co., Pine Bluff, Ark.
Williams, J. S., assistant to superintendent of system operations, Pennsylvania Power & Light Co., Hazelton, Pa.

22 to grade of Member.

ELECTRICAL ENGINEERING EDUCATION



AIEE in the University of Idaho

STUDENTS at the University of Idaho became members of the Electrical Association, forerunner of the AIEE, in 1906, under the leadership of Professor Sydney Sheldon. At the time, Professor Sheldon was assisted by instructor S. E. Hutton in teaching the 28 students majoring in electrical engineering. Today, the department numbers 240 students, and the College of Engineering has a teaching staff of 31.

The five divisions of the College of Engineering, agricultural, chemical, civil, electrical, and mechanical, are housed in five buildings located on the campus at Moscow, Idaho. One of these is the $510,000 Engineering Building constructed in 1950. The Kirtley Laboratory, electrical engineering unit equipped for work in power, electronics, and radio, was built in 1949.

One of the most impressive structures on the University of Idaho campus is the Administration Building. Constructed in 1907, it houses the office of D. R. Theophilus, president of the university, staff offices, classrooms, and library facilities.

Development of the Klystron Tube

R. E. JACOBSON
STUDENT MEMBER AIEE

ENGINEERS AND SCIENTISTS have wanted to use higher frequency signals for a number of reasons. Since the ordinary vacuum triode could not fulfill their needs without introducing unconquerable problems, these men sought other means of amplifying, oscillating, and multiplying their high frequency signals. Out of this search came the idea of velocity-modulated tubes, of which the klystron is an important type.

This presentation will discuss the advantages of using higher frequencies, the problems encountered in developing a high-frequency tube, and finally the solutions to these problems.

High-Frequency Transmission

One of the major reasons for using higher frequencies (above 300 mc) or shorter wave lengths is the principle of physical optics which states that radiation in a directed beam can arise only from a structure that is large in comparison to the wave length. This means that in order to transmit a narrow beam effectively without resorting to very large antennas, it is necessary to use very short waves.

From a military standpoint, it is easy to visualize how much more economical and practical it is to use a higher frequency so that smaller antennas can be installed in aircraft.

One other major reason for transmitting at high frequencies is the elimination of disturbing noises in transmitting and receiving devices caused by discharges and transients in electrical machinery. Inasmuch as these discharges and transients do not contain components in the high-frequency range, the disturbing noises are automatically eliminated.

Klystron Development

The klystron is a special type of vacuum tube which has many high-frequency applications as amplifiers, oscillators, frequency multipliers, and mixers or detectors. This article describes the development of the klystron as a double resonator amplifier tube. Its normal operating range is from 300 to 50,000 mc.

The major problem encountered when

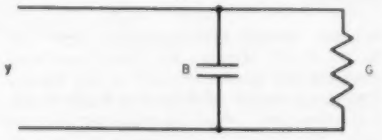


Fig. 1. Triode input admittance
where
$B = j\omega C_{gk} [C_{gp}(A_x + 1)]$
$G = j\omega C_{gp} A_y$
A_x = real component of the gain
A_y = imaginary component of the gain

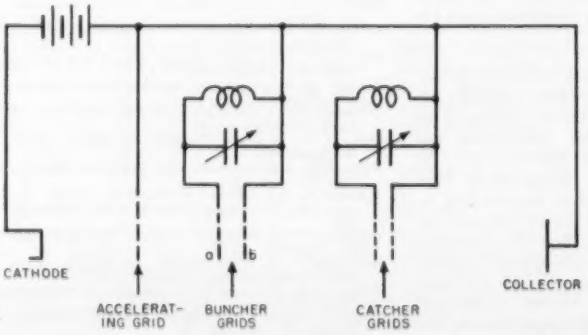


Fig. 2. Klystron schematic diagram.

Text of paper awarded first prize in the North Eastern District Student Prize Paper Contest.

R. E. Jacobson is a student at the University of Massachusetts, Amherst, Mass.

The author is indebted to Prof. John Mohn of the University of Massachusetts for his guidance and advice during the preparation of this paper.

the triode vacuum tube is used at high frequency is the interelectrode admittances. The input admittance of the triode tube can be expressed as shown in Fig. 1.

With an increase in frequency, the susceptance B increases, as does the conductance G. In effect, the total admittance increases, allowing a larger grid current to flow. Because it is not desirable to have a large grid current flow from the standpoint of increased grid losses and decreased efficiency, another means of amplifying the high-frequency signal must be used.

There is no problem of interelectrode impedances in the klystron tube. In this tube, the electrons are emitted from a filament-heated cathode and are attracted immediately by the large d-c potential of the accelerating grid, as shown in Fig. 2. The d-c potentials of the accelerating grid, buncher grids, catcher grids, and the collector are the same, so that, in effect, all the d-c acceleration of the electrons occurs in the region between the cathode and the accelerating grid. Inasmuch as the electrons receive no more acceleration after they pass through the accelerating grid, they will tend to maintain their maximum velocity acquired by the previous acceleration until they reach the collector.

After passing the accelerating grid, the electrons first come upon a pair of buncher grids which are situated very close together and connected to one side of a tuned circuit excited by a high-frequency signal. If the polarity on the grids is such that grid a is positive and grid b negative then, as the electrons pass through, their speed is decreased. If grid a is negative and grid b positive as the electrons pass through, their speed will be increased. The crest value of the high-frequency voltage is much less than the d-c voltage, so the number of electrons passing through the buncher grids is constant. As a result, very little power is taken from the alternating signal source because as many electrons are accelerated as decelerated. This process is known as velocity modulation.

The beam of electrons as it leaves the buncher grids is not directly usable. In Fig. 3, let the length of the vectors represent the relative velocities of the electrons. The smallest vector is that of the electron which left the buncher grids at time t_o (negative b, positive a). The largest vector is that of the electron which left the grids at time $t_o + 1/2f$ or a half cycle later (positive b, negative a). As the electrons leave the buncher grids, they travel in a field-free drift space of the tube. At some time after traveling in this drift space, the faster electrons will overtake the slower electrons, resulting in electron bunching. The result is that density modulation can be produced by first velocity modulating the beam of electrons and then allowing a long drift time to occur so that the electrons can bunch.

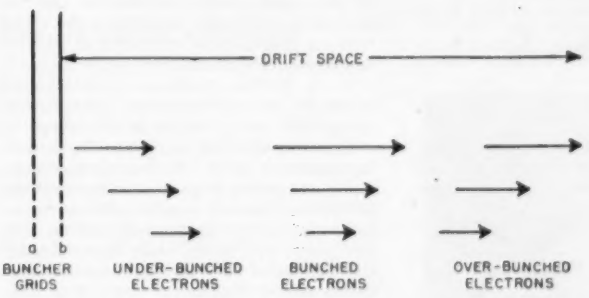


Fig. 3. Electron bunching.

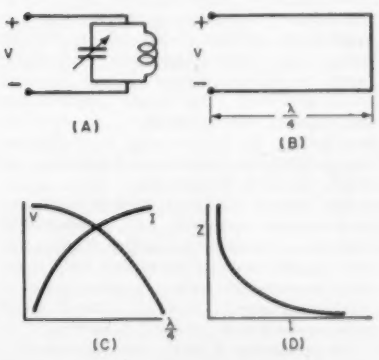


Fig. 4. Equivalent circuits.

Theoretically, at least another pair of grids (catcher grids shown in Fig. 1) can be placed at the position where the electrons bunch and an alternating voltage could be taken from them to supply a resonant tank circuit. But because of high-frequency effects on simple wired circuits, that is, the radiation losses and inductance in the leads to the tube elements become very great, another method is employed.

It can be established mathematically that a short-circuited quarter-wave-length lossless line at high frequencies functions the same as a parallel L-C resonant circuit at low frequencies. But, for the sake of simplification, it will be proved here by comparing the characteristics of the two circuits. In a lumped-parameter parallel circuit, as shown in Fig. 4(A), at the resonant frequency the input current is a minimum and the input impedance is a maximum. The distribution curves of a quarter-wave-length shirt-circuited lossless line are shown in Fig. 4(A) and 4(B). It can be seen that the input current is a minimum and the input impedance is a maximum in this circuit as well. Inasmuch as the characteristics of the two circuits are the same, the transmission line can be use as a resonant tank circuit at the high frequencies.

An infinite number of quarter-wave-length lossless transmission lines connected in parallel to a high-frequency oscillator would look like Fig. 5(A) and 5(B). If the high-frequency oscillator were removed and some holes were punched into the cylindrical container or cavity, as shown in Fig. 5(C), and a stream of bunched electrons passed through at the proper frequency the cavity would act as if the oscillato were still there. The cavity would resonat at the predetermined frequency. It is assumed that the positive electrons are movable. As the first bunch of electrons passes through the openings, it induces a positive charge first on one side of the cavity and then on the other. The positive charge can be thought of as moving with the electrons, although it is confined to the surface of the cavity. When this first bunch of electrons leaves the cavity, the positiv charge will move back to its origin position. Upon returning, it will tend to oscillate at the resonant frequency of the cavity about this position before coming to rest. If this oscillation is such that when the next bunch of electrons enters the cavity the entrance side is positive and the exit side negative, then the electrons will be slowed down and their energy will be used by the cavity to sustain the oscillations.

These oscillations set up electric mag-

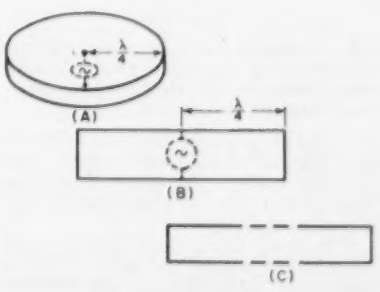


Fig. 5. Klystron cavity.

netic waves within the cavity itself. In order to convert the energy from the beam passing through the cavity to useful energy, a coaxial cable is coupled into the cavity with the center conductor acting as a small antenna to pick up the induced electric magnetic waves. The coaxial cable then transmits this energy to a load.

The operation of the cavity can be reversed and energy can be fed into the cavity by means of this coaxial cable. The cable will set up an electric field within the cavity and, in effect, alternating charges will be produced at the center holes. When used as an input cavity, these alternating charges have the same effect on a beam of electrons as the buncher grids described at the beginning of this discussion.

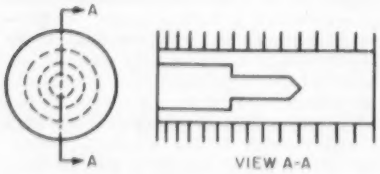


Fig. 6. Klystron collector.

Another major problem in building a high-frequency tube is in designing the collector or plate. There are two conflicting requirements involved: the collector must be small to operate at these high frequencies and, yet, it must also be large to dissipate all the heat created by the fast moving electrons as they strike it. In the klystron tube, the cavity is used to extract the high-frequency power, so the collector will not have to be small. Usually, the collector of the large-power klystrons is made with the shape shown in Fig. 6.

This irregular interior design is to trap the electrons from the collector and cut down on the release of secondary electrons. The outside fins are used to dissipate the heat to the air. Sometimes the plates get so hot that forced air is necessary to cool them.

Conclusion

In closing, it might be worth while to summarize the advantages of the klystron amplifying tube and its operating capacities. These advantages are:

1. The electrons are first velocity modulated with no unconquerable problems and are then automatically density modulated. This method takes very little power from the signal source.

2. By using two cavities, one for input elements and one for the output elements, undesirable radiation losses and inductive effects are eliminated.

3. Since a cavity is used for the output element, the collector can be built for better dissipation of the heat to the air.

Commercially, the klystron ranges from 4 milliwatts at 50,000 mc to 20 watts at 470 mc. However, it is assured that many of the tubes made for the military services fall outside this wide range. The theoretical efficiency is approximately 58 per cent, but as the result of secondary electrons and unpredictable cavity effects, the actual efficiency is nearer 30 per cent.

In addition, it should be stated that even though the klystron has undergone much development and improvement, it still lacks the power requirements demanded of a tube in the 300- to 50,000-mc range.

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Rutgers University Receives Gift of Pace Analog Computer

A computation laboratory was established at Rutgers University in February through the gift of a $15,000 Pace analog computer from Electronic Associates, Inc., of Long Branch, N. J., it was announced by Dean E. C. Easton of the Rutgers College of Engineering.

Dean Easton said the laboratory is primarily instructional and will serve to make engineering students aware of the value of electronic computation as a tool for the engineer. He said relatively few colleges in the country have such a facility.

"Eventually we plan to have each engineering student use the computation laboratory in connection with several of his courses," Dean Easton said. He added that the laboratory will also be available for graduate thesis work and for the basic research program of the College of Engineering.

The dean also announced the purchase of a Philbrick analog computer, which will be used to supplement the gift computer from Electronic Associates.

The Philbrick computer is simpler but less accurate than the Electronic Associates unit.

"Together they will provide the simplicity needed for beginning instruction and the accuracy needed for serious engineering calculations," the dean said.

Union College Selected for Expanded ORSORT Program

Dr. Carter Davidson, president of Union College, Schenectady, N. Y., recently stated that the selection of the college as one of the co-operating universities in the expanded nuclear training program of the Oak Ridge School of Reactor Technology (ORSORT) was ". . . one of the greatest honors ever bestowed upon Union College."

The other universities selected for the program were Carnegie Institute of Technology, Case Institute of Technology, Northwestern University, the University of California at Los Angeles, and the University of Florida.

Under the new university co-operation plan, six months of the training in fundamentals of reactor technology will be taken at the participating universities and six months at Oak Ridge. Previously, the entire training program was conducted at the Oak Ridge National Laboratory.

Dr. A. H. Fox, professor of mathematics at Union, has been appointed co-ordinator of the ORSORT program at the college.

Union College has been devoting increasing attention to the nuclear energy field. Currently, graduate level courses are offered in nuclear physics, nuclear chemistry, reactor theory, and reactor engineering. Special projects in recent years have included the training of two atomic submarine crews and a summer course for a group of General Electric scientists. Both of these were sponsored by the Knolls Atomic Power Laboratory.

University of Alabama Reports on Branch Activities

The joint AIEE-Institute of Radio Engineers (IRE) Student Branch at the University of Alabama holds a minimum of 12 meetings during the school year. The meetings are presided over by J. D. DeLorenzo, chairman, a senior electrical engineering student. Other officers for the branch are, Carl Armstrong, vice-chairman; Al Wyatt, secretary; and Rayford Davis, treasurer. The faculty advisors for the branch are, Professors of electrical engineering, W. F. Gray and P. H. Nelson, representing the national organizations of AIEE and IRE respectively.

The branch activities include films and speakers on technical and nontechnical subjects, a semiannual Ladies Night, student paper competition, several field trips, branch-sponsored teams to participate in intramural sports, and an annual social meeting to honor graduating seniors.

On November 6, 1956, the Alabama Section of AIEE sponsored a field trip to the Allis-Chalmers Plant at Gadsden, Ala.,

Electrical Engineering Education

where the group observed the manufacture of distribution transformers and to the General Electric Tube Plant at Anniston, Ala., where the group observed the manufacture of various types of electron tubes. While in Gadsden, the group was served lunch by the management of Allis-Chalmers.

On December 11, 1956, the Alabama Section of AIEE sponsored a program and banquet at the University of Alabama campus. Twenty-nine members from the section attended the meeting.

The Joint Student Branch has 98 paid members with all of the senior class being members of one or both of the organizations.

With the activities planned or in the planning stage, the Joint AIEE-IRE Student Branch at the University of Alabama anticipates a highly successful year.

Western Electric Establishes Engineering Education Program

A broad, new engineering education program will be established by the Western Electric Company to keep its working engineers abreast of the latest developments and implications of their expanding fields.

Three "Engineering Training Centers" will be organized by the company in the New York, N. Y., Chicago, Ill., and Winston-Salem, N. C., areas for engineers to take full time courses while temporarily detached from their regular assignments. The program is scheduled to begin in September 1957.

All new engineers hired by Western Electric will take part in the program, beginning four to six months after they start work. The new engineer will take a nine-week series of introductory courses, followed by a series of general development courses about a year after he has joined the company. The second series of courses will last about 10 weeks.

The company's experienced engineers will receive more advanced development courses on the basis of their qualifications, need, and capacity. These courses will relate to their specialized fields and also will be held at the three Engineering Training Centers.

More than 600 engineers are expected to take part in the program during 1957. In 1958—the first full year of the program—about 4,000 will participate. Western Electric, the manufacturing and supply unit of the Bell Telephone System, employs some 6,300 engineers among its more than 125,000 workers in some 50 American cities.

Besides being designed to meet the engineering challenge of tomorrow in the strictly technical sense, the Western Electric educational program was organized to help equip the engineer for his increasingly responsible role in a technological civilization. In addition to subjects based on the physical sciences, including electronics, manufacturing, and communications, courses will be offered in human relations, the sociological impact of engineering, and new horizons in engineering.

The program was established following an industry-wide survey undertaken last summer by a task force of Western Electric engineers and training specialists to clarify the training needs for engineers.

Summer Institute Planned for High-School Science Teachers

The National Science Foundation and the US Atomic Energy Commission will sponsor a one-month institute for high-school science teachers at the Special Training Division of the Oak Ridge Institute of Nuclear Studies (ORINS) July 29 through August 23, 1957.

ORINS is a nonprofit educational organization of 35 southern universities, operated under direct contract to the US Atomic Energy Commission, which is cooperating in the presentation of the summer institute.

Forty-eight high school science teachers will be accepted for participation in the institute and each participant will be awarded a stipend of $300. A dependency allowance of $60 per dependent (up to $240) and a travel allowance of 4¢ per mile (up to $80 for the round trip) will be available to all participants.

This summer institute is designed to pro-

An Electrical Engineer in Education

W. A. LEWIS (AM '27, M '39, F '45), research professor of electrical engineering, Illinois Institute of Technology, Chicago, Ill.

"Energy available in a useful and readily controllable form is the essential ingredient in man's progress. By using other forms of energy than his own physical resources, man amplifies his efforts, so that he can rise above a bare physical existence, and enjoy the fruits of his labors. Electric energy provides that need in the most versatile and easily controlled form, and the present living standards would be impossible without it. The AIEE, as the foremost organization for the dissemination of technical information in this field, provides the medium for continued and expanding progress. Every electrical engineer who hopes to make a contribution to the world in which he lives needs the help of the AIEE and it, in turn, needs the support of every progressively minded electrical engineer."

Professor Lewis began his professional career as a wireman and draftsman for Westinghouse Electric and Manufacturing Company (now Westinghouse Electric Corporation). After nearly three years of practical experience, he entered California Institute of Technology, where he received the degrees of B.S. in E.E., M.S in E.E., and Ph.D. He then returned to Westinghouse in electric utility engineering and was engaged in studies of power system stability and protection, carrier current for protection and control, railway electrification, relay development, and similar activities, as well as consulting service for customers. In 1939, he was appointed director of the School of Electrical Engineering at Cornell University, and in 1944 he joined Illinois Institute of Technology as research professor of electrical engineering. He served as dean of the Graduate School from 1946 to 1955, and now occupies the Professorship of Electric Power Systems sponsored by a group of utility and manufacturing companies.

Prof. Lewis has served the AIEE on National Technical Committees since 1934 and is now participating in the broader fields of Standards, Research, Planning and Co-ordination, and Prize Awards. He has presented a variety of papers on technical subjects and also in the areas of education and research. He has served as chairman of the Committee on Basic Science and Research and vice-chairman of the Committee on Protective Devices, as well as chairman of several subcommittees and working groups. Recently, he was named head of the AIEE Professional Development and Recognition Department.

vide a selected group of teachers in the physical sciences with up-to-date reviews of scientific developments, classical and modern, stressing that science should be taught and learned as a whole, rather than as a series of highly specialized technologies. The institute is intended to improve the subject-matter competence of science teachers and to strengthen their capacity to motivate student interest in science. Among the lecture topics will be classical and modern physics, chemistry, science experiments, and science-teaching methods. Atomic energy and radioisotope techniques will also be discussed, but not stressed. Both lectures and laboratory work will be incorporated into the curricula. Assisting in presenting the institute will be a number of outstanding authorities in various fields of physical sciences, such as F. B. Dutton, Michigan State University; M. D. Peterson, Vanderbilt University; and W. G. Pollard, ORINS.

No formal grant of academic credit is made by ORINS for attendance at the institute, although participants may explore the possibilities to such arrangements with individual universities.

Selection of participants will be made from applications, which must be accompanied by a letter of endorsement from a responsible official of the applicant's school. Deadline for return of applications for the institute is April 1.

Application blanks and additional information may be obtained by writing Dr. R. T. Overman, chairman, Special Training Division, Oak Ridge Institute of Nuclear Studies, P. O. Box 117, Oak Ridge, Tenn.

AEC Approves Loan of Uranium Metal to Three Schools

The Atomic Energy Commission (AEC) has approved three loans, each of 5,500 pounds of natural uranium metal, plus neutron sources, to North Carolina State College, Raleigh, N. C.; The Ohio State University, Columbus, Ohio; and Rensselaer Polytechnic Institute, Troy, N. Y. The uranium and neutron sources will be used in subcritical assemblies for the training of nuclear engineers.

The subcritical assembly consists of an arrangement of uranium rods in a moderator such as graphite or ordinary water. When the neutron source is introduced, nuclear fission is produced, but the reaction cannot be sustained without the presence of the neutron source.

Such assemblies do not require the complex control mechanism, expensive shielding or heat removal equipment of nuclear reactors, and may be used for many laboratory exercises in nuclear engineering training.

The 5,500 pounds (2,500 kilograms) of uranium metal to be loaned to each institution will be in the form of rods enclosed in aluminum. This brings to 16 the number of loans of this type to nonprofit educational institutions.

The AEC for some time has been supplying certain materials for these assemblies without a use-charge being made, subject to the availability of the material and to a determination that such loans will advance the AEC program to assist in alleviating the current shortage of nuclear scientists and engineers.

Stanford Announces Fellowships and Assistantships

Stanford University has released an announcement of fellowship and assistantship opportunities in electrical engineering to graduate students in a program of course work and organized research. Its aim is to provide for each student's individual needs by making available courses in engineering, physics, and mathematics as well as courses in other departments of the university.

The following fellowships are offered: Stanford University Graduate Fellowship, $2,400; Hewlett-Packard Medical Electronics Fellowship, $2,000–$2,500; International Business Machines Fellowship, $2,000–$2,500; Hewlett-Packard Fellowship, $2,000; Firestone Tire and Rubber Company Fellowship, $2,000; Wesix Research Fellowship, $1,750; Westinghouse Fellowship, $1,700; Federal Pacific Electric Manufacturing Corporation Research Fellowship, $1,650; Consolidated Engineering Fellowship, $1,500; Sylvania Electric Fellowship, $1,500; Harris J. Ryan High-Voltage Fellowship, $500; Holophane Company Illuminating Engineering Scholarship, $500 (also open to qualified undergraduate students); Tuition Fellowships, up to $510 (available to teaching assistants only).

Teaching assistants receive $1,500 to $3,750 for half-time work during the nine-month academic year. These positions provide valuable opportunities to participate in a university-level teaching program. A number of Tuition Fellowships will be awarded to teaching assistants.

Research assistants receive $1,500 to $3,750 for half-time work during the nine-month academic year. Research projects currently active at Stanford involve transistors, microwaves, electron tubes, radio propagation, computers, network theory, control systems, servomechanisms, high-voltage, and illumination.

Good students can complete graduate work for the M.S. degree in about a year

New Engineering Drawing Lab

Courtesy Herb Weitman

REPRESENTATIVES of the Mississippi Valley Structural Steel Company and of Washington University inspect a new laboratory for engineering drawing at the university, for which the company donated $15,000 to remodel and equip. The laboratory will be used in a new drafting course in architectural and civil engineering and is equipped to provide for 24 students at a time.

and a half, while receiving both financial support and professional experience from a teaching or research assistantship.

For application forms and further information, write: Assistantship Committee, Electrical Engineering Department, Stanford University, Stanford, Calif. Applications should be received by March 15, 1957.

University of Illinois Offers Quality Control Course

The 10th annual short course in Quality Control by Statistical Methods will be offered by the College of Engineering, University of Illinois with the co-operation of the Division of Engineering Extension at Urbana, Ill., from March 11-21, 1957. Intensive work will be given in the fields of control charts and acceptance sampling with some attention paid to the rational setting of specifications and tolerances. It is designed for those in the areas of design, production, procurement, management, quality control, and inspection.

For further information, write to: Professor J. A. Henry, Mechanical Engineering Laboratory, University of Illinois, Urbana, Ill.

GE Fellowships Offered by Case Institute of Technology

For the 11th consecutive year Case Institute of Technology will offer 50 all-expense General Electric Science Fellowships to preparatory and high school teachers of physics from the north central states area for a special six-week study program that will run from June 16 through July 26, 1957.

In announcing this year's program, Dr. Elmer Hutchisson, dean of the graduate school and director of research at Case, said that applicants for the fellowships, sponsored by the General Electric Company (GE), must be college graduates, possess experience in preparatory or high school teaching, and be certified to teach in their respective states.

The program is open to qualified teachers from: Illinois, Indiana, Iowa, Kentucky, Michigan, Missouri, Minnesota, Ohio, Western Pennsylvania, Tennessee, West Virginia, and Wisconsin. Travelling expenses to and from Cleveland, Ohio, as well as the cost of living on the Case campus, books, tuition, and fees are included in each fellowship grant.

Purpose of the program is twofold: to provide preparatory and high school science teachers with a comprehensive review of the physical sciences and to present an introduction to the most recent developments in nuclear physics.

Two afternoons each week are spent visiting greater Cleveland research centers, such as GE's Nela Park laboratories and the NACA Lewis Flight Propulsion Laboratory, as a supplement to the classroom work.

Members of the Case Institute of Technology faculty who will conduct the program are: Dr. R. S. Shankland; Ambrose Swasey, professor of physics and head of the department; Dr. L. O. Olsen, professor of physics; R. C. Putnam, professor of electrical engineering; and Dr. R. L. Sutton, professor of physics.

Dr. Shankland will review: "Recent Developments in Atomic and Nuclear Physics"; Dr. Olsen and Dr. Sutton: "Basic Concepts in Physics"; and Professor Putnam: "Science and Technology in the Control of Environment." Sharing the teaching duties with Professor Putnam will be representatives of the lamp development laboratory and engineering department, GE Lamp Division, Cleveland, Ohio.

Applications for the 1957 GE Science Fellowships may be obtained from: Dean Elmer Hutchisson, Case Institute of Technology, 10900 Euclid Ave., Cleveland 6, Ohio.

In addition to the study program at Case, GE will also offer summer courses for high school math teachers at Rensselaer Polytechnic Institute, Troy, N. Y.; a summer program for high school math teachers at Purdue University, Lafayette, Ind.; and summer courses for secondary school chemistry and physics teachers from northeastern states at Union College, Schenectady, N. Y.

Enrico Fermi Professorship Planned by University of Chicago

Plans to endow an Enrico Fermi Distinguished Service Professorship at The University of Chicago in memory of the world renowned nuclear physicist have been announced by Dr. M. J. Kelly, president of Bell Telephone Laboratories.

Dr. Kelly will serve as chairman of a national committee to establish the professorship.

The professorship, to be established at the University's Institute of Nuclear Studies, is designed to perpetuate and memorialize Dr. Fermi's scientific contributions. He was both teaching and conducting research at the Institute at the time of his death in 1954.

Serving with Dr. Kelly will be W. L. Cisler, president of Detroit Edison Company; Dr. C. H. Greenewalt, president, E. I. du Pont de Nemours & Co. (Inc.); and Admiral Lewis Strauss, chairman of the United States Atomic Energy Commission.

Honorary members are Clare Boothe Luce, former American Ambassador to Italy, and Dr. Manlio Brosio, Italian Ambassador to the United States. In addition, an extensive Advisory Subcommittee will be formed.

Raytheon Fellow Studies at Harvard Graduate School

D. S. Falk of Long Island City, a Raytheon Fellow, is continuing his studies at the Harvard Graduate School of Arts and Sciences under the sponsorship of the Raytheon Manufacturing Corporation.

In 1955, Mr. Falk was awarded the Raytheon Fellowship in Physics, one of a series of scholarships and fellowships made available by industrial firms. The fellowship lasts two years and covers the cost of tuition, fees, and a substantial allowance for living expenses.

Mr. Falk is a graduate of Cornell University where he received the B.E. with distinction in 1954. He received the A.M. from Harvard in 1955 and during the 1954-55 school year held a National Science Foundation Fellowship. The National Science Foundation was established by an Act of Congress in 1950.

His current research concerns the field theory and theoretical nuclear physics.

NYU To Begin Program in Industrial Engineering

A new program in industrial engineering has been announced by the New York University College of Engineering. It will "better prepare students for the demands of new industrial engineering methodologies—automation, operations research, data processing, and human engineering," according to Prof. N. N. Barish, chairman of the department of industrial and management engineering.

Beginning with the 1957 spring semester, students will be permitted to follow either a scientifically oriented "core" program that stresses advanced mathematics, chemistry, and physics, or one of five specialized engineering programs. Options in the latter include aeronautics, electronics, metallurgy, and structures and transportation, as well as the traditional mechanical engineering.

In addition, all industrial engineering students will study the human behavioral sciences, industrial engineering and management, cultural studies, and graphic expression.

"The new program," said Prof. Barish, "opens the door to graduate work in a particular branch of engineering if the student should become more interested in the technical than the industrial applications." He added that "basic courses in mathematics and science are emphasized to give the student breadth of coverage and flexibility in solving original problems."

OF CURRENT INTEREST

National Bureau of Standards

AN OBSERVATORY housing a sensitive photoelectric photometer set up at an altitude of 9,000 feet by scientists of the Boulder Laboratories, National Bureau of Standards, for tracking and studying the airglow. Observations can be made only on moonless and cloudless nights.

Instruments That Will "See" Invisible Airglow Light at Night

SIX INSTRUMENTS that can "see" light intensity not visible to the human eye are being shipped to science laboratories near and far by the Boulder Laboratories of the National Bureau of Standards (NBS).

Of major importance to world-wide studies to be carried on during the International Geophysical Year (IGY) which begins July 1, 1957, these photoelectric photometer telescopes automatically take a sweeping look at the night sky every four minutes.

The object of their scrutiny will be a variable glow that diffuses the sky at night but is so dim to the human eye that it is seen only rarely.

Equipped with filters to separate colors, the instrument already in use since 1954 at the Boulder Laboratories has informed scientists that airglow is composed of several different colors: infra-red, red and green, emitted by oxygen atoms; and yellow, emitted by sodium atoms. Filters transmit very pure colors and block out interfering radiations from space and the photometer measures intensity of the glow and automatically records its changing patterns over the sky.

For some time, airglow has been thought to be related to the aurora, the colorful spectacle commonly known as Northern or Southern Lights, which always becomes more frequent and more brilliant as sunspot activity reaches its peak in an 11-year cycle.

During the IGY, scientists will intensify efforts to understand the direct cause of the aurora. The theory most widely accepted now attributes it to electrons expelled with great velocity from the sun, especially during violent solar disturbances and entering the upper atmosphere, exciting the gases to luminosity. Such high-speed particles move in spiral paths along the lines of force of the earth's magnetic field, converging toward the magnetic poles.

National Bureau of Standards

CHAIN OF STATIONS training photometers on a faint glow that pervades the night sky called airglow.

Detailed cause of the airglow, however, is not known. It has been suggested that the part of the upper atmosphere where it originates has many photochemical reactions that excite the atoms so they may glow. This point of view has led to the expression "chemical kitchen" for the 50 to 70 mile high region.

A more recent idea is that the airglow is caused by winds which are thought to be at least as strong in the upper atmosphere as near the earth's surface. If this proves to be true, then airglow studies may actually lead to a knowledge of these winds between the earth and interplanetary space.

Dr. Franklin Roach of the Boulder Laboratories is project leader for the U. S. program of airglow studies for the IGY. He and his staff have spent much time the past year in training personnel and equipping co-operating laboratories to assure operation of the American continental chain of stations with identical instrumentation and techniques.

Most of the stations are close enough so that the areas of upper atmosphere under

observation overlap one another. For purposes of camparison, one station at another longitude is also being equipped at Sydney, Australia.

The American continental chain will run through Thule, Greenland; College, Alaska; Resolute Bay, Baker Lake, Churchill, The Pas, Saskatoon, Canada; Rapid City, S. Dak.; Fritz Peak, Colo.; Sacramento Peak, N. Mex., U. S. A.; Tonanzintla, Mexico; Huancayo, Peru; to San Juan, Argentina. Five of these are NBS equipped stations.

Data from the stations will be correlated with that supplied by other foreign countries. Since airglow varies in intensity from time to time and from place to place international co-operation is imperative.

At Boulder Laboratories will be a data processing center for analyzing data and measuring records on airglow information. By using IBM equipment, scientists plan to have all data processed by July 1959.

Study of the airglow data, especially when correlated with other kinds of upper atmosphere studies, is expected to give scientists information about the composition, temperature, and behavior of the upper atmosphere which is as much of a mystery now as were the oceans before the time of Columbus.

Analog Computer Programmed with Punched Tape

A TOTALLY NEW analog computer series, combining a digital output-input translater system (DO/IT) with many other features designed for automatic operation and high accuracy, has been produced by Berkeley Division, Beckman Instruments, Inc.

By using a typewriter and punched-tape system to set up and check problems, EASE (registered trade mark) *1100* series computers save hours of operating time, take much of the human element out of computing, and make practical an installation of any size.

The electric typewriter system permits complete computer control—including pot set and electronic function generator setup. Solutions can be run and rerun automatically with the punched tape.

As a point-by-point check, the typewriter first prints the desired address and value. After the servo-set system nulls, the actual address and value set is printed.

Coefficient and amplifier values read out on a printer and can be stored for future use.

Other new features of the *1100* series include the patchbay system, complete pushbutton monitoring, automatic problem checking, redesigned servo-set potentiometer system, and a highly stable temperature-controlled oven.

The new computer uses Aircraft-Marine Products' cellular, shielded, and insulated patching system, consisting of molded nylon blocks alternated with interlocking metal strips.

Cellular construction of the board prevents terminal-to-terminal leakage. Patching can be changed and inspected at any time without disconnecting board power.

Patch cords select amplifier use, such as integrator, summer, or high gain, keeping entire problem on the board. Patch cord control of amplifiers eliminates need for disconnecting computer power when removing patchboard.

Two patch bays are available—a 2,200 hole board for a 60-amplifier computer (Model *1132*) and a 3,600 hole board for a 100-amplifier installation (Model *1133*).

Pushbutton monitoring of all amplifiers and coefficient potentiometers is a standard feature. Optional features include pushbutton monitoring of multiplier, function generator, and resolver outputs; potentiometer arms, trunk lines, and power voltages.

Another pushbutton feature—for static and integrator problem checking—insures that all patching is correct and all components are operating. It immediately locates cause and location of any error.

The new clutch system offers greater accuracy and reliability, according to Berkeley engineers. In less than 3 seconds, any one of 100, 10-turn 50-kilohm potentiometers can be set to an accuracy of better than 0.01 per cent.

As an alternate system, a new packaging technique puts 100 manually adjusted potentiometers at the operator's fingertips. Potentiometers are assembled in vertical drawers, mounted side by side.

All computing resistors and capacitors are adjusted to better than 0.005 per cent and mounted in a temperature-controlled oven set at 113 F. Temperature varies no more than 0.8 degree at any point in the oven.

A simple adjustment procedure, using a preset time and hold unit, insures that capacitors can be maintained within tolerance.

The EASE *1100* series consists of three basic systems with a group of "building block" components designed to provide the exact equipment needed for a specific installation.

Berkeley's EASE computers can test-fly aircraft on the drawing board by simulating actual flight conditions.

In July 1956, Berkeley delivered to the Allison Division, General Motors Corporation, one of the largest analog computers ever assembled. This 10-ton mass of electronic equipment, grouped in 29 metal cabinets 6 feet high and spanning a width of nearly 60 feet, is used by the engineers to simulate jet engines electronically. With the instrument, capable of solving with lightning swiftness high-order differential equations involved in design work, designers can picture an engine in action under varying conditions before it has been built.

Among the most promising of Berkeley's new developments is the tiny ferristor, a miniature magnetic amplifier with redesigned circuitry for increased speed and reduced size, utilizing a 50-year-old electromagnetic principle to create a totally new concept of industrial instrumentation. Reliability, the toughest problem electronics manufacturers face, comes nearer solution with the development of this new component. These tiny circuit elements perform most vacuum tube functions with the speed and precision of electronic vacuum tubes, and offer the unfailing reliability, simplicity, and long service life of electromagnetic devices.

Insulated in epoxy resin, ferristors are immune to damage from shock, vibration, moisture, and overload. They are nonaging, require no filaments, operate at extremely low current and voltage levels, and produce little or no heat. The first instruments built around ferristors, a dual preset controller, and a long life events-per-unit-time meter, are expected to operate for many years without service.

CHECKING THE ACTION of the new EASE *1100* series takes the hard work out of computing by eliminating most of the manual operations needed to set up, check, and recheck problems. The punched tape input does the work instead of the engineer.

Third Dimension Modern Housekeeping

Remote and automatic space control in the kitchen is the basic theme of an advanced research project developed recently. Entitled the "RCA Whirlpool Miracle Kitchen," the exhibit, which is completely functional, has been designed to demonstrate possible future mechanical kitchen innovations that are in various stages of development in the Whirlpool-Seeger engineering and research laboratories.

In a spotless, filtered, air-conditioned kitchen, illuminated by indirect lighting, a self-propelled serving cart will detach itself from a dishwashing mechanism in the wall, move to a dining table, deliver complete table service or receive soiled dishes, then return to its nest in the wall to dispose of waste and do the dishes. The entire operation is by predesigned control.

The kitchen floor is kept spotless by a mobile floor cleaner which functions automatically. Dispatched by remote control, the "mechanical maid" disappears into a base cabinet recess when the scrubbing job is done. There it recharges itself with washing agent and water for the next cleaning operation. It can also be used as a waxer and polisher. Both the dishwasher cart and floor cleaner are powered by batteries which are automatically charged when the units are in their respective wall niches.

At the wave of a hand, a refrigerator moves down from a wall cabinet to convenient reach-in level. Temperature and humidity are accurately regulated in each compartment to provide ideal conditions for preservation of various foods. A fruit and vegetable storage drawer glides out from a base cabinet, as does a similar freezer compartment.

Beverages may be stored at proper serving temperatures in bottles or in bulk. Hot or cold liquids may be dispensed from bulk storage compartments into a drinking glass on contact with an automatic tap. An inexhaustible supply of clear ice, in any size from large cubes to fine powder, is dispensed in the same manner.

Located at appropriate work centers throughout the kitchen, these refrigerated compartments are frost-free. One central cooling unit, a method called "piped cold" serves all.

Other operations which take place automatically at the wave of a hand include food storage shelves that are lowered from wall cabinets to an accessible level, a utensil storage drawer that glides open, a drop-down storage rack for drinking glasses, and a self-cleaning mixing unit which will drop from wall cabinet storage to counter and mix, blend, grind, or shred foods at selected speed and duration. Part of this unit is removable for use as a portable, self-powered mixer.

Meal preparation is simplified by self-cleaning, automatic cooking facilities. An oven with automatically controlled time and electronic energy descends to counter level for easy accessibility and rises again for ultrafast cooking. A menu selection control at the planning center activates a completely automatic meal maker which moves selected prepared foods from cold storage to compartments for cooling, warming, or cooking. In addition, there is an electronic grill for broiling meats and vegetables.

Photo Courtesy Whirlpool-Seeger Corp.

CABINETS, accented by colorful panels, stand several inches off the floor for easy cleaning of kitchen. Remote control floor cleaner (*left foreground*) disappears into its base cabinet. Lighting ranges from white to blue to pink, or any combination of the three. Light is diffused by an arched ceiling and soffits of translucent vinyl. Both lighting and floor cleaner are operated from the freestanding planning center (*left*) which also contains touch controls for audio and visual communication, food selection, recipe selection, an automatic meal maker, and a mobile combination dishwasher-serving cart.

Usable also as work surface or dining bar, a surface cooking range has a number of tiny disks which will release energy on contact with specially designed utensils. The cooking-serving utensils are constructed so that the exterior remains cool while the food heats. An electronic fan and air purifier system draws grease, odor, and moisture from the air through ventilating slots located behind each thermostatically controlled contact unit.

The semicircular range wraps around the back of a freestanding planning center which is the heart and brain of the RCA Whirlpool Miracle Kitchen. On it are touch controls for audio and visual communication, food selection, recipe selection, the mobile dishwasher cart, the floor cleaner, and the automatic meal maker. At the planning center, a rotating TV monitor, visible from any point in the room, shows at a glance activity at the front door, nursery, game room, or any other location about the house. A standard television broadcast may also be received on this screen.

Other features of the kitchen include color projection of recipes on the wall, a large wall projection surface for color television reception, an inventory panel that shows exact status of food on hand and would advise the grocer of shortages, and a canned food dispenser which will deliver a can intact or open it automatically, release the contents and destroy the can.

Elevator sinks are custom-adjusted to the height of the user. Temperature and flow of water are controlled by push-buttons. When not in use, the two sinks may be concealed under movable counter-top panels.

In an adjoining laundry area is a new combination washer-dryer that washes up to 10 pounds of clothes out of water by giving the clothes a shower instead of a bath. The wash cycle utilizes only three gallons of water plus that absorbed by the clothes.

Autotransformers for Bonneville Power Administration

The last of six single-phase autotransformers, largest ever built, was shipped recently from the power transformer department of the General Electric Company (GE) at Pittsfield, Mass.

Each of the big units, rated 200,000 kva and weighing 205 tons, was built with a one-piece tank and transported upright (see cover photograph). They will be used to step the voltage up and down between 345,000 and 230,000 volts on the Bonneville Power Administration (BPA) system in the Pacific Northwest states.

Autotransformers change voltage without electrically isolating the incoming and outgoing electrical circuits, because part of the single winding is common to both. They generally cost less than conventional power transformers with separate, insulated windings.

Their use at high transmission voltages, with attendant savings to utilities, has been made possible by recent research findings in insulation and protection against overcurrents. Thyrite (registered trade mark) resistors, pioneered by GE, help protect the

autotransformers from high voltage lightning and switching surges. Thyrite is a special material which acts as an insulator under normal operating conditions but becomes a conductor when voltage exceeds a predetermined value.

The BPA autotransformers were designed with the aid of a card program calculator and an electromagnetic model to help determine the best arrangement of core steel, copper windings, insulating, and cooling elements.

Each autotransformer is cooled by its insulating oil, which circulates by convection through external radiators. Two banks of fans blow air through the radiators to increase the cooling capacity.

Focus on the Figure of the Earth

Aircraft flying faster than sound and guided missiles that must be launched and controlled with great precision have greatly increased the need for exact information on our world. As the amount of this information increases, new problems arise in making it quickly and easily available upon demand. Geodesy, the science of measuring and delineating the earth's surface together with its size and shape, is called upon to give the necessary precision.

Necessity, in this as in other fields, is a strong incentive for research. Because of current developments in commercial and military fields, the study of the exact size and shape of the earth is being more actively pursued than ever before. One of the key centers of this research is The Ohio State University.

Geodesy began to receive special attention at Ohio state about 30 years ago. This interest was sparked by E. F. Coddington, professor of civil engineering whose attainments included a doctorate in astronomy, and teaching experience in mathematics and mechanics.

Following World War II—in which maps were a very vital element in global military planning—emphasis on teaching and research in earth measurement increased. Special recognition was given with the establishment of the University's Mapping and Charting Research Laboratory, and the Institute of Geodesy, Photogrammetry and Cartography.

As is known, the earth is not quite a perfect sphere but rather a spheroid, bulged out at the equator by the centrifugal force of rotation and flattened at the two poles. However, there are numerous other regional irregularities which the geodist refers to as "undulations." Locating and charting any place with great exactness and accuracy requires determination of these wrinkles on our geoid—to use the scientific name for the idealized sea-level surface without mountains and other elevations and depressions.

Gravity, the pull that makes unsupported bodies fall, is used in determining these irregularities. Its precise measurement, with computation of variations from theoretical values, is a world-wide project. In addition to the Ohio State Institute, there are organizations in Paris, France; Helsinki, Finland; and Moscow, U.S.S.R.

Measurements are received from Government surveys, oil companies (gravimetric data are used in prospecting for petroleum), and other sources. Some of these are made on land, others at sea—especially beneath its surface in submarines, or directly on the shallower ocean floors. The information thus compiled is reduced to standard values that can be shown on maps as variations or anomalies from the computed or theoretical figures for those locations. They are given in milligals, i.e., thousandths of a gal, which is the unit of gravitational acceleration named for Galileo.

There are still many unmeasured localities, particularly at the little traveled parts of the oceans, but they are gradually being surveyed to complete the world-wide network of gravimetric measurements. Additional work in this field is part of the program for the International Geophysical Year (IGY) beginning in July 1957. This definitely is a long-range project, inasmuch as there will always be need for additional and more precise gravity data.

Radar is thought to be one of the possible methods applicable. In many places, particularly over water where tape cannot be used, electronic methods will be utilized to give measurements that are much more accurate than any now available. However, for relatively short distances on land, traditional optical and mechanical methods with modern refinements in the instruments remain satisfactory. Modern geodesy involves a complex mingling of old and new methods. Electromagnetic and electronic devices will supplement rather than supplant theodolites in carrying lines and triangulation systems across the country. Instruments known as geodimeters are coming into extensive use for running traverse lines. They use electronic controls and modulated light waves, weigh 20 to 50 pounds, and are mounted on tripods.

Sun, moon, and stars observations still will be necessary in order to "tie" points on the earth's surface to the poles, the equator, and the prime meridian at Greenwich, England. Earth's familiar satellite, the moon, is expected to be supplemented during the IGY by man-made satellites that will be launched under Operation Vanguard. These will be equipped to send back radio signals from which their initial progress can be tracked. They will also be observed photographically and visually from observation stations located all the way around the world.

In order to realize the potential scientific value of the satellite, it is essential that its launching be carefully planned, and that enough observations be obtained at different times and places to permit rapid and accurate computation of its orbit. The height at which it moves is a critical factor, too. At 100 miles above the earth, the air drag will limit its life to about an hour. At 200 miles away, it may last for about two weeks. At a distance of 300 miles away from the earth's surface, there is a possibility that it may last approximately a year.

An impressive array of scientific talents is being directed toward developing ways of locating places on the earth with greater and greater precision, and of showing these locations on maps in such a way that they may be useful in navigation at supersonic speeds.

Future Meetings of Other Societies

American Institute of Chemical Engineers, March 3-6, Greenbrier Hotel, White Sulphur Springs, W. Va.

National Biophysics Conference, March 4-6, Columbus, Ohio.

High Speed Computers Conference, March 5-8, Louisiana State University, Baton Rouge, La.

PMI, Annual Spring Technical Meeting, March 6-8, Hotel Carter, Cleveland, Ohio.

National Electrical Manufacturers Association, Annual Meeting, March 11-14, Edgewater Beach Hotel, Chicago, Ill.

American Society of Mechanical Engineers, Meetings:

Gas Turbine Power Conference, March 18-21, Sheraton-Cadillac Hotel, Detroit, Mich.

Engineering Management Conference, March 27-28, William Penn Hotel, Pittsburgh, Pa.

Instrument and Regulators Conference, April 7-10, Northwestern University, Chicago, Ill.

Spring Meeting, April 8-10, Dinkler-Tutwiler Hotel, Birmingham, Ala.

International Atomic Exposition, March 11-15, Architects Building, Philadelphia, Pa.

Society of American Military Engineers, 3rd Military—Industrial Conference-March 14-16, Conrad Hilton Hotel, Chicago, Ill.

Nuclear Studies Medical Division Seminar No. 1, March 18-19, Oak Ridge Institute, Oak Ridge, Tenn.

IRE, Radio Engineering Show, March 18-21 New York Coliseum, New York, N. Y.

American Society of Tool Engineers, Silver Anniversary Annual Meeting, March 25-27, Shamrock Hilton Hotel, Houston, Tex.

American Society for Metals, 10th Western Metal Exposition and Congress, March 25-29, Pan-Pacific Auditorium and Ambassador Hotel, Los Angeles, Calif.

19th Annual American Power Conference, joint meeting of 14 universities and 9 technical societies, sponsored by Illinois Institute of Technology, March 27-29, Hotel Sherman, Chicago, Ill.

Radiation Effects on Materials, joint Office of Naval Research, Navy Dept. Glenn L. Martin Co., and Johns Hopkins University colloquium, March 27-29, Shiver Hall, Johns Hopkins University, Baltimore, Md.

Society of Plastics Engineers, Regional Technical Conference, "Plastics for Building," April 3, New York, N. Y.

Air-Conditioning and Refrigeration Institute, Government–Industry Symposium, April 3-5, Commerce Department Auditorium, Washington, D. C.

Refrigeration Service Engineers Society, Educational Forum, April 5-7, Sheraton-Palace Hotel, San Francisco, Calif.

Gas Appliance Manufacturers Association, Annual Meeting, April 8-10, Greenbrier Hotel, White Sulphur Springs, W. Va.

American Welding Society, Annual Spring Meeting, April 8-12, Annual Welding Show, April 9-11, Philadelphia, Pa.

Electrical Engineers (ASEE) Exhibition Ltd., Sixth Exhibition, April 9-13, Earls Court, London, England.

Missile-Launching Ship Commissioned by U.S. Navy

THE U. S. NAVY's experimental ship, *USS Compass Island*, forerunner of a fleet of nuclear-powered, ballistic missile-launching vessels, both surface and submarine, was commissioned recently at the New York Naval Shipyard.

A converted mariner-class cargo vessel, the *Compass Island* is being equipped with "the most fantastic array of navigation instruments ever assembled in a ship," the Navy said. Its mission is to speed evaluation of new inertial aids for precise midocean navigation and to expedite launching of the Fleet Ballistic Missile.

Key to its all-weather, all-latitude, day and night capability is the ship's inertial navigation system (SINS). This system, which also includes celestial trackers, is a new development of the Navy's Special Projects Office of the Bureau of Ordnance and Sperry Gyroscope Company. It is based on fundamental investigations and research performed for the Navy by Dr. C. S. Draper of the Instrumentation Laboratory, Massachusetts Institute of Technology and was further developed for manufacture by Sperry's Marine Division. The system determines ship position (latitude and longitude), true North, and the ship's speed over ground.

"We know the ballistic trajectory our missile will follow; we know the location of the target," said Garrison Norton, Assistant Secretary of the Navy for Air, at the commissioning of the *Compass Island*. "But to achieve success we must know the location of our launching point to a degree of accuracy never hitherto attained at sea. The dome on the navigation tower resembles a small observatory, which is exactly what it is. The telescope requires no observer—where the human eye would normally play its part we find instead a photoelectric cell, so sensitive that stars become visible in daylight."

He went on to say that the telescope sits on a stabilized platform which will remain precisely level, regardless of rolling and pitching of the ship. The telescope will automatically align itself upon a star, and the operator will be able to read the bearing and elevation angle to greater accuracy than a navigator could achieve with a sextant.

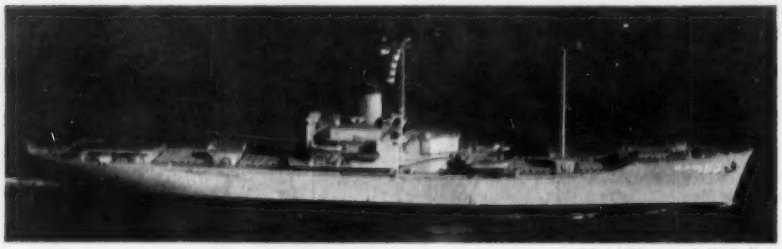
The miniature astronomical observatories are mounted on a 67-ton navigational tower located just forward of the ship's superstructure. This tower provides a rigid structure isolated from ship flexures, to give fixed reference planes from which to make celestial computations. The instruments used for measuring angle are as accurate as those possessed by the world's finest astronomical observatory.

This is the beginning of tests in this ship with new tracking devices which will be able to see the sun, moon, and a few special stars known as radio stars, by detecting the radio signals given off by these heavenly bodies. Celestial navigation will then be possible even when the sky is entirely covered with clouds. It is expected that this ship will be able to locate its position by taking radar ranges on the moon.

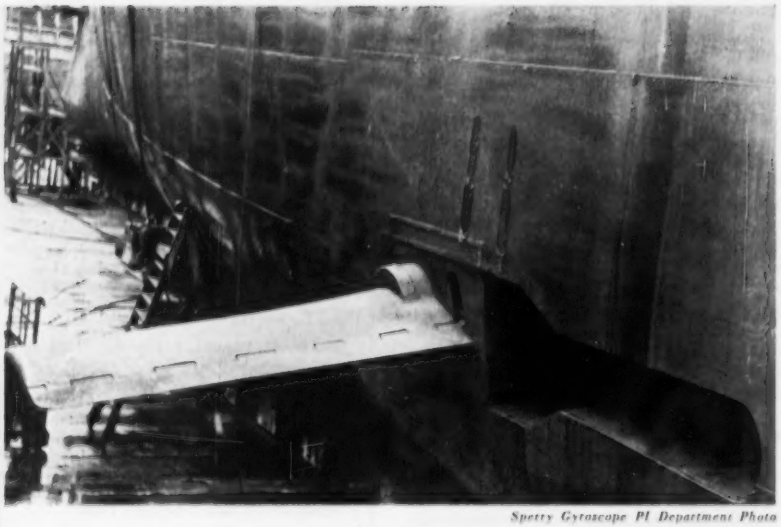
The new navigational system now installed in the *Compass Island*, will aid not only missile ships, but eventually may help all types of ships. It also may bring about revolutionary changes in the field of cartography.

The *Compass Island* will roll less than one-tenth as much as her sister ships in the same seaway because of her Sperry Gyrofin (registered trade mark) ship stabilizers. This stabilization, currently in use for passenger ships, is of extreme importance to the launching of missiles. While sister ships may be rolling 15 degrees, the *Compass Island* will roll about a degree and a half. This is accomplished by underwater fins, one on each side of the vessel, approximately midway between bow and stern. Action of the fins is automatically controlled from the bridge by instruments which measure roll rate, roll angle, and roll acceleration. From instrument data, Gyrofin continuously computes the proper stabilizing moment and by its unique lift control feature assures accurate application of the stabilizing moment to the ship. These compact sensors then transmit, through magnetic amplifiers, the required antiroll signals to hydraulic actuators which directly operate each fin shaft. The fins may be retracted into recesses in the hull.

At the commissioning of the ship, its captain, Cdr. Dare, remarked that the date happened to be the 181st Anniversary of the commissioning of the first ship in the U.S. Navy. That ship, by coincidence, also was a converted merchantman. It was commissioned on December 3, 1775, by Lt. John Paul Jones.



Official Photograph U. S. Navy



Sperry Gyroscope PI Department Photo

USS COMPASS ISLAND (EAG-153)—the U. S. Navy's experimental navigational ship—will be one of the most comfortable riding ships in the Navy. She has the best automatic steering available, and in addition has activated fins for roll-stabilization. Retraction of both fins when not needed is accomplished by folding them back into recesses in the hull. Through modern computer techniques, minute power of the sensing instruments is multiplied 24-million times to obtain exact antiroll forces of precision magnitude and timing. The fins, moving in the water, develop "lift," either up or down, to counter the ship's roll. The amount of lift depends upon the fin's tilt or "angle of attack" relative to the direction of water flow.

Covet Not Thy Neighbor's Draftsman—Act!

THERE ARE commandments by which men live that say "Thou shalt not steal," and "Thou shalt not covet thy neighbor's wife, nor his man-servant, nor his maid-servant, nor his ass, nor anything that is his." Should this latter commandment perhaps include "nor his draftsman?"

It seems rather sad that men of industry should even have this thought come to mind. However, there is reason for such thoughts, and more than 250 representatives from industry, education, and Government in the Delaware Valley area met at an all-day session to discuss openly and reach realistic conclusion toward alleviating the reason for thinking in this vein—one of the nation's most serious, yet least discussed manpower shortages, the lack of qualified design and drafting personnel.

The delegates met to initiate concrete steps for solving the problem at the Design and Drafting Workshop sponsored by the Design and Drafting Council of the Delaware Valley on November 17, 1956, in the Burroughs Research Center, Paoli, Pa.

The Design and Drafting Council came into being in a very informal manner; in a manner not uncommon to the American tradition of eliminating problems through intergroup understanding and co-operation. Several representative executives met at one of their many meetings, and the conversation took a natural turn toward "shop talk" and the expression of their problems. It evolved that there was one problem in common—the lack of necessary engineering support people. The discussion of the problem then became more intensified, and gradually grew into the suggestion that perhaps, by joint action on the part of industry, something concrete could be accomplished. This contemplation of joint action was further expanded to include representatives of education, technically concerned local Government agencies, and civic associations. From this active conversation evolved the steering committee of the Design and Drafting Council of the Delaware Valley, and in place of discussion, positive-action—the first step of an intelligent approach toward local solution of a nationwide problem.

The primary aims of the Council are: to point up the significance of the manpower shortage in the fields of design and drafting; to stimulate the concerted action of industrial, educational, and communal leaders in taking steps to offset the problem; to air in a positive, realistic manner current design and drafting personnel and technical problems; and to make strong, positive "co-operative-action" recommendations in several directions:

1. The encouragement of youth to enter the design and drafting professions. This would include aid to educators in the form of curriculum assistance where there is a need.
2. The increase and improvement of industrial training for drafting supervisors and design and drafting personnel.
3. Improvements relative to employment practices in recruiting design-drafting personnel.
4. Clarification and ultimate uniformity of classification and qualification requirement factors for design and drafting personnel.

E. R. Chappell, special assistant to Secretary of Labor Mitchell, in his keynote address to the Workshop delegates, said that ". . . only through advances in our educational systems and our training programs—on the job, in our schools, and in our skill-development techniques—can we effectively meet the threat of our technical manpower shortage as it exists today, and as we anticipate it will exist in the future."

Mr. Chappell further informed the representatives of the national objectives of a Department of Labor program aimed at the development of skills for creation of an effective workforce, which at present is greatly lacking in adequate numbers of qualified engineering support personnel. This program is, in essence: (1) finding the facts and informing the nation about the need for trained people; (2) helping people select, prepare for, and obtain the right jobs; and (3) the promotion of more adequate training programs throughout the economy. He also stressed the fact that there is an important new dimension in today's technical manpower problem—quality.

Although the need for engineers has been widely publicized, little attention has been focused on the diminishing supply of "second echelon" personnel. This second echelon in the world of technology is composed of the draftsmen, designers, and technicians urgently needed to fill the support jobs currently done by engineers. The meteoric speed at which our technology is expanding has created an indisputable demand for release of engineers for engineering.

The seriousness of this contemporary problem is clearly set forth in the words of Dr. R. L. Johnson, president of Temple University and honorary chairman of the Council: "These highly skilled second echelon technicians, although frequently undervalued, form the backbone of today's technological gains, and unless the current and projected shortage of skilled designers and draftsmen is alleviated, the present inefficient utilization of our scientific manpower will grow."

T. W. Hopper, executive vice-president of Day & Zimmerman, Inc., told the delegates while introducing the speakers at the conclave, that it has been estimated in an industrial center such as Philadelphia, Pa., that "the cost of advertising for draftsmen and designers has amounted to almost $25,000 per week. This figure is duplicated in most other metropolitan areas where there is a heavy concentration of technical personnel. Week after week, this tremendous sum is spent in a great effort to find drafting talent. This money is spent, not in educational endeavors or for developing such talent, but in enticing experienced personnel into the fold of individual organizations." Time has proved that this apparently is not the answer, or an effective approach to solution of the over-all problem.

PANEL DISCUSSION GROUP *concerned with industrial recruitment practice, is shown in session. The panel members are (left to right):* Mr. G. Keller, General Electric Co.; Mr. A. Waltrich, Machine and Tool Designing Co.; Mr. W. Callaghan, Minneapolis-Honeywell, Brown Instrument Division, Moderator; Mr. J. M. Vincombe, Jr., Radio Corporation of America.

A more formidable approach to ultimate solution of the problem of deficiency in adequate numbers of engineering support technical personnel was suggested at the first meeting of the Council Steering Committee on July 18, 1956. This suggestion embraced public airing of a common problem usually kept within the confines of individual organizations. Thus was born the First Annual Design and Drafting Workshop.

In addition to hearing the principal addresses by Mr. Chappell and J. B. Doak, prominent Philadelphia attorney and representative of the Philadelphia Chamber of Commerce, the delegates attended four panel discussions which resulted in positive-action recommendations designed for immediate partial solution and ultimate complete solution to the engineering support personnel shortage. The specific panels were: (1) education encouragement and curriculum assistance; (2) industry training needs and practice; (3) industrial recruitment practice; and (4) uniform position titles and classifications.

The specific subjects under discussion in the panels included such considerations as pre-industry training in the schools, the place of training in the design and drafting fields, specialized training for upgrading, the means by which training programs can be sold to management, the true meaning of industrial training, training for drafting supervisors, and specialized training for work peculiar to operations. The delegates also considered such points as the use of outside agencies as sources of manpower, current recruiting practices and problems, the benefits of contract engineering services, techniques of recruiting technical and subprofessional personnel, the importance of realistic job classifications and descriptions, and the personnel department's role in classification uniformity.

As a result of industry's leaders meeting under one roof to roll up their sleeves and state their problems uninhibitedly, the problems were aired realistically, and on an industry-wide basis, rather than in the narrow confines of an individual operation or firm. The Workshop pointedly showed management that all the fields of engineering—electrical, mechanical, aeronautical and others—share a common problem, burden, and obligation. It further provided an opportunity for industry to voice opinions and recommendations aimed at alleviating the engineering support personnel shortage.

As an expedient, it was recommended that a joint committee of industrial and Government personnel be formed to consult with educators on matters relative to curriculum. It was also pointed out that the ultimate results of this action must be accomplished through recognition of the young men and women who successfully complete the courses. The most effective recognition, it was decided, would be the hiring of the students, which means that industry must modify their emphasis on seeking only experienced personnel.

In contrast to the encouragement of students, it was suggested that over-age personnel with years of experience in the fields of design and drafting be encouraged to re-enter the drafting room, or utilize their specialized "board" experience in teaching these fields in the public schools. It was felt that this could be accomplished by alerting the "40-Plus Clubs" and engineering societies of the urgency of the situation, and making them aware of the opportunities available.

Betameter Controls Tire Fabric Calendering

Recent achievements in the field of automation and radiation gauging have produced a new control concept for the rubber industry.

The Betameter, a machine which utilizes radiation from a radioactive source as a primary control mechanism, now allows extremely accurate control of tire fabric calendering operation. The device permits adherence to close tolerances in the production of rubber sheet, resulting in more uniform tire fabric—and better tires—at no increase in cost.

The Betameter, produced by Isotope Products, Buffalo, N.Y., is in use at the Los Angeles, Calif., plant of the Goodyear Tire and Rubber Company. The unit, which has been in operation for a number of months, has been acclaimed as a revolutionary development of rubber process control.

It consists basically of a radiation source and detector which translates radiation energy from the source into an electric signal. When material is placed between the source and detector, a portion of the radiation is interrupted in direct proportion to the mass of the material. The Betameter can then be calibrated in terms of any units of weight over unit area desired.

Response of the new gauge is extremely rapid, enabling use of automatic process control. Primary advantage is that at no time does any element of the machine contact material being measured. Hand samples and other destructive and time-consuming control methods are now obsolete. In the case of rubber, being easily deformable, noncontacting gauging is particularly valuable, because contacting gauges would compress the stock, giving a false reading.

Advanced methods of electronic design, incorporating principles of "null balance," permit simplified construction and highly accurate and stable measurement. In addition, the unit automatically compensates for variations in ambient temperature, pressure, and decay of the radioactive source. Periodically, the unit is automatically self-standardized to further insure accurate and reliable control.

Two twin sets of measuring elements are installed on the pass line, one set after each of the calenders. In this way, the sheet is measured after coating one side of the fabric and again after coating the opposite side. The Betameter, thus, can determine and control the thickness of coating on either side.

Each measuring element of the twin set is located on opposite sides of the 60-inch web giving two control positions at each location, thereby insuring more accurate and uniform production. The measuring elements have a dual source incorporating a 12-inch distributed source or a 1½-inch point source. Either can be activated by the use of an automatic shutter. The distributed source is used for control inasmuch as it samples a larger area to average the point variation in cord distribution.

Many other safety provisions are incorporated to prevent damage to the calender or the product. An excess error device locks out automatic control in the event of excessive deviation from specification in the event of a process failure.

To provide definite correlation between length of record chart and fabric production, the chart is directly synchronized to the fabric speed by a selsyn motor interlock. In this fashion the chart moves one inch for every 100 yards of product. To provide time correlation when analyzing charts, date and time are automatically stamped on the chart every 15 minutes.

To assist the operator in establishing new specifications and in setting and controlling the calender stack manually, exact position of the calender rolls is indicated on the control console.

The Betameter, even though using a powerful radiation source, is adequately protected and shielded so that at no time does it constitute a hazard to the operator. If at any time, the power should fail or it is desired to perform mechanical work on the unit, an automatic shutter will isolate the radioactive source. Betameter rays have absolutely no effect on rubber nor does the rubber assume any residual radioactivity.

Self-Controlled Reactor Shuts Itself Off

The "self-controlled" ability of an atomic energy research reactor to shut itself off if abnormal operating conditions occur has been demonstrated in tests conducted by Atomics International, a division of North American Aviation, Inc.

The tests have been made with a 50-kw solution type, or "water boiler," research reactor specially constructed for the work at the company's Santa Susana Mountains field laboratory, about 30 miles northwest of Los Angeles, Calif. The program, called KEWB (kinetic experiment for water boiler reactors), is being conducted for the Atomic Energy Commission (AEC).

The object of the KEWB program is to study the detailed operating characteristics of the solution type reactor, one in which the nuclear fuel is contained in a water solution.

Studies include demonstration of detailed physical qualities which cause the reactor to shut itself off if it is subjected to abnormal or unusual operating conditions. This automatic shut-down characteristic, inherent in the solution type reactor, is due to temperature increases and formation of gas bubbles in the reactor fuel which results in the termination of the atomic fission process. Studies are also being conducted to determine the best reactor operating methods from the standpoint of general efficiency.

Atomics International has built several solution type reactors now operating in the United States. Reactors of this type are now being constructed by the company for installation in West Germany, Japan, and Denmark. This reactor type is particularly suitable for nuclear radiation studies and applications to the medical, industrial, and research fields.

Power Engineering Revolution Forecast at New York Exposition

Forecasts of an impending revolution in the mechanical world were strongly impressed on visitors at the 22nd National Exposition of Power and Mechanical Engineering in the New York Coliseum, New York, N. Y., November 26-30, held under the auspices of The American Society of Mechanical Engineers, concurrent with the organization's annual meeting. Widespread interest in the exhibits attracted a large attendance estimated at 30,000 visitors for the week, from all walks of industry and commerce.

The most impressive displays in the well-rounded exhibition were models of atomic power stations whose construction closely impends. The most spectacular were those of guided missiles, heralding the impact of rocket engines on commercial flight. The most significant were exhibits of materials, structures, and components that indicated the extent to which manufacturers of power plant equipment and production machinery are not only spreading out into new fields, but also soaring to new and higher standards in conventional product design.

One aspect of the upsurge in research and development that the exposition forecast is the tremendous investment that is going into experimental and production facilities, all of which consume power and demand increased power production. This demand is rapidly being satisfied by the consumer industries themselves, and even more extensively by the public utilities.

By 1957 a $100 million generating station will be ready for the network of New Jersey's Public Service Electric & Gas Co. (A scale model of it was at the exposition.) This station will have the peculiar advantage that while it will buy oil from a refinery close by, it will also sell steam to be used in refining the oil.

Private industry's staggering investment in new and projected plants will be financed conventionally, in part, but also often by joint participation. The 134,000-kw pressurized water atomic reactor plant of the Yankee Atomic Electric Co. (a model of which was shown), is the project of 12 public utilities, whose power lines blanket the New England States. Incidentally, the Yankee will be the first atomic power plant to use fuel elements of stainless steel containing slightly enriched uranium.

An important segment of the expansion among the engineering industries will produce components and equipment for atomic plants, missile power, and more extensively than heretofore for aircraft. Even the fissionable fuel and solid propellants for atomic plants and missiles, respectively, come from manufacturing plants, instead of being mined or pumped out of the earth, like the traditional fuels. There were several exhibits in both classifications at the Coliseum.

A number of remarkable new designs have been created to serve prosaic purposes —such as pumping—for the new industrial needs. A "coolant" pump to circulate sodium and other molten metals at temperatures up to 1,600 F and flow rates as high as 5,000 gpm (gallons per minute), was one of the astonishing developments which the exposition uncovered. Another was a coolant pump designed to circulate 18,300 gpm of water at 580 F. This is more than twice the temperature of boiling water. Within recent memory boiling water could not be pumped because it would evaporate!

The "canned," or hermetically sealed pump, of which the foregoing are examples —often having but one moving part—has come ahead rapidly in all applications. One new model this year has been developed for hard-to-pump liquids, whether hazardous, corrosive, volatile, or hot. Its construction eliminates packing and seals, and it can be operated with practically no routine maintenance. Several other new units of this type were also on view.

One of the innovations in metals was a new magnesium alloy for use under elevated temperature conditions. It is available in sheet, plate, extrusions, and sand castings. High-resistance alloys in the ranges required to meet revolutionary designs were exhibited at another booth, along with a practical demonstration of ductile iron's remarkable properties.

Aluminum tubes and tube sheets may replace admiralty metal in surface condensers and several other applications in steam, if joint studies by a producer of the metal, an equipment manufacturer, and several utility companies continue favorable, it was disclosed at one of the exhibits. Advantage would lie in cost-saving plus the greater resistance of the aluminum alloys to ammonia, carbon dioxide, and hydrogen sulfide.

Another large segment of exhibitors displayed electric motors and transmissions. This field is divided between motor manufacturers who, in part, produce geared power units for various applications, and manufacturers of transmissions who also offer motorized reduction gears. The result is an extensive selection of units, many of which have been designed to meet the specific needs of machine-tool drives. Numerous belted variable-speed drives, as well as one all-metal speed variator were displayed.

A maker of synchronous motors in sizes between clock types and fractional horsepower ratings offered one model for laundry timers, depth finders, heating controls, integrators, time switches, chart and potentiometer drives. Another had a line of totally enclosed, blower-cooled, rapid reversing motors, as well as a constant cutting-speed drive and a packaged all-electric a-c adjustable-speed drive.

Among the more significant aspects of the exposition was the evidence of continued growth in the market for package boilers, indicated both by the number of exhibitors in that line and their more extensive offerings. The array included several exceptional designs, such as the electric immersion type boiler, which first appeared at the Power Show a number of years ago as a piece of laboratory equipment, but is now offered in a variety of portable and stationary applications; and a return-flow boiler with internally finned tubes for accelerated heat transfer.

For applications requiring wide swings in steam demand, the smaller package units are often installed in batteries of several units, for step-by-step, ON-OFF operation under full load. Automatic control simplifies this method of operation. A recent development in package boilers is the panelized control, permitting remote operation of the small steam plant.

An unusual development is the application of the package concept to a sizable coal/oil convertible boiler, which is capable of being broken down into several units for shipment and installation, but otherwise carries out the idea of the completely equipped and home-plant tested unit.

Measuring devices and control equipment for pressure, temperature, liquid flow, liquid level, and other applications were shown in the full range and variety characteristic of the exposition. One manufacturer's application of the module principle to the design and mounting of miniature instruments attracted attention by reason of its interchangeability. The system is adaptable to the control, regulation, and data recording of an entire steam plant or processing sequence.

The comprehensive display of materials handling equipment included among other new presentations, a conveyor actuated by a revolving lead screw, which has unique advantages, and an in-plant tractor with remote radio control which permits a single operator to handle the loading of an entire trailer train. A companion unit is an electronically controlled tractor that is steered, started, and stopped automatically by tracking tape laid on the floor.

High speculative interest centered in the display by the research department of one of the oil companies of a simulated free-piston gas turbine, which appears to be adaptable to the automobile, has shown comparable test results, and is similar to engines on which several manufacturers now are engaged.

Induction Motor for Small Gas-Engine Starting

A new high-torque a-c induction motor for instant electric starting of small gasoline-engine equipment such as lawn mowers, is now available from the General Electric Company's (GE) General Purpose Motor Department.

Push-button starting is a feature of the lightweight starter motor. The cord from the motor can be plugged into any 110-volt garage or household electrical outlet. After the engine is running, the motor is then unplugged and the mower is ready for duty.

The motor is simple and rugged in design, according to GE engineers. It is directly connected to the mower shaft, eliminating the need for clutches, belts, and pulleys. Similar motors can also be applied to gas and gasoline-engine-driven machines such as motor scooters, golf carts, garden tractors, snow shovelers, and natural-gas air conditioners.

Higher starting torque characteristics of the capacitor-start, induction-type motor assure instant starting of gasoline engines. The simple design of the unit minimizes maintenance, the engineers said. For lawn mower starting, a 15-ampere house fuse will carry this high-torque motor under normal conditions.

Creation of Council for Atomic Age Studies

Columbia University recently announced the creation of a "Council for Atomic Age Studies" (CAAS) through which the University's broad resources are being mobilized for an attack on the "new and awesome" problems of the atomic era.

The objective of the council is to make Columbia a center for the study of problems facing society as a result of the development of atomic energy, problems which in many instances overlap a number of fields of activity and different branches of learning. Areas of study represented on the CAAS itself include physics, engineering, medicine, international relations, journalism, business, philosophy, and law.

Creation of the council, believed to be the first such effort by a university in the United States, comes just 18 years after atomic fission experiments on the Columbia campus signalled the beginnings of the Manhattan District Project. Activation of the institution-wide effort is viewed by Columbia authorities as one of the most important steps to be taken in the university's post-war era.

The CAAS, it was explained, will stimulate, organize, and supervise studies, drawing on the competence of many disciplines and activities of Columbia University to examine some of the effects of the development of atomic energy on such diverse areas as industry, law, economics, foreign policy, international relations, agriculture, physical and mental health, domestic economy, city planning, and community life. (The effects of such areas in turn on atomic development may also require study.) Possible studies include various issues in the international development of atomic power which involve research in technology, law, economics, and foreign policy. Similarly, there is need to consider, in joint studies, the effect of new forms and sources of power on industry and agriculture, on physical and mental health, on our domestic economy and our communities.

Dr. Grayson Kirk, president of Columbia, in a statement concerning the undertaking, declared:

"Columbia University has already begun to deal with the new and awesome problems facing society as a result of the development of atomic energy. Enormous and urgent, these problems in many instances transcend the competence of any one discipline or faculty.

"To date, atomic questions of a primarily scientific or engineering nature have received the major share of attention. There is urgent need, however, to concentrate also on the host of problems which are arising from the impact of atomic development on the several aspects of our life and civilization.

"The atom, confronting us both with a terrifying threat of destruction and a promise of great benefits, is profoundly affecting our society in areas outside the domain of physics and technology. Because of its location and resources, Columbia University, we believe, has an opportunity and a responsibility to provide a center for essential research—and to co-operate with private industry, civic groups, and foundations, and with Government and international agencies, including the new International Atomic Energy Agency—toward the solution of such problems."

Members of the CAAS are men prominent in their fields. They are: I. I. Rabi, Higgins Professor of Physics and Nobel Prize winner; P. C. Jessup, Hamilton Fish Professor of International Law and Diplomacy; E. W. Barrett, dean of the Graduate School of Journalism (Columbia University); W. T. R. Fox, professor of International Relations and director of the Institute of War and Peace Studies; Charles Frankel, professor of Philosophy; Menelaos D. Hassialis, professor of Mineral Engineering and director of the Columbia University Mineral Beneficiation Laboratory (AEC); D. W. O'Connell, assistant professor of Banking and assistant dean of the Graduate School of Business; J. G. Palfrey, professor of Law; David Shemin, professor of Biochemistry of the College of Physicians and Surgeons; J. M. Kernochan, professor of Law and director of Columbia University Legislative Drafting Research Fund; and Louis Henkin, on leave from the State Department to direct one of the projects of the group.

Columbia University News Office Photo

EXAMINING A LIST of projects to be undertaken by the new Council for Atomic Age Studies are: Professor I. I. Rabi (*left*), President Grayson Kirk (*center*), and Professor P. C. Jessup.

Motor Runs for 57 Centuries

After the equivalent of 5,787 years, a much-abused motor finally broke down a few weeks ago—and one of the longest and most fundamental motor testing programs in industry was almost over. Almost, because one last motor is still running and, in theory at least, it may go on forever.

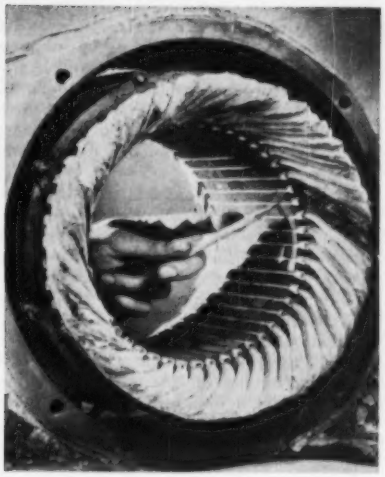
If it does, the test never will attain one of its objectives: determining the maximum life of silicone insulation in motors. Another objective, "minimum life," was settled some time ago, but "maximum" is still unknown. High test temperatures either oxidized the copper or warped the rotor, causing motor failure while the insulation was still effective.

The program began in October 1943 as a joint project of Dow Corning and Westinghouse Electric. In all there were eight motors: 10-hp 1,190-rpm 3-phase induction units, fitted with special end-bells and asbestos shields to isolate the bearings. Six units were insulated with silicone bonded and impregnated materials. For comparison, two were Class B insulated.

All eight motors were generator-loaded to produce average copper temperatures ranging from 200 C to 310 C. Operating time at temperature was divided into heats, each $\frac{1}{25}$ of the motor's estimated maximum life. The heats were alternated with 24-hour conditioning periods at 100% (per cent) relative humidity. An abrupt drop in wet insulation resistance—the point at which crazing appeared on the varnish surface—would be taken as "minimum life." Actual insulation failure, of course, would be "maximum life."

It was anticipated that the test would run about a year or so. Both Class B units did fail and catch fire just about as expected, and the silicone insulated motors showed an abrupt drop in wet insulation resistance at the predicted times as well.

Contrary to expectations, the drop was not followed shortly by total insulation failure. Instead, the motors kept right on operating. The 310-C motor, for example, was expected to fail within a week or so. It lasted over seven months. So did one of the 300-C motors, and the other held on for a year, breaking down because of copper oxidation.



AFTER 60,000 hours at 240 C, original silicone varnish has evolved into something like glass, but its bond strength, insulation resistance, and water-repellency are still good.

Even after the varnish had crazed, it still maintained a good bond, holding the other components in place. It never evolved into a conductor, because of its silica backbone; and it stayed hydrophobic.

It took six years before a formal and final report could be made to the AIEE [*Transactions*, vol. 68, pps. 1133-38 (1949)], and even then the two 240-C motors were still running. But the practical usefulness of silicone insulation had been demonstrated so effectively that the AIEE had already recognized it as "Class H" (for "high temperature").

A few years later the last two motors still operating were transferred from the electrical lab of the Dow Chemical Company where they—and Dow Corning—had started, to a brand-new test stand at the Dow Corning plant.

But now, after some 60,173 hours at 240 C, one of them (see illustration) has failed because the heat-warped rotor dragged on the stator (note rub marks), pulling laminations until one pinched through a slot. It has run the equivalent of 360 years at standard Class H hottest-spot 180-C temperature, or an unbelievable 5,787 years at conventional Class A 105-C limits.

It is doubtful, of course, that any motor could operate 5,000 years. As mentioned, copper oxidation is solely responsible for all the breakdowns in the test except this last one. Here excess heat warped the rotor until it rubbed the stator, pulling stator laminations until one finally pinched through slot and wire insulation.

As a result, the one remaining motor in the test was equipped with a new rotor. Stator insulation, however, was untouched. Chemically, that insulation is closer to glass than it is to varnish, but the motor has already run longer at 240 C than a Class A motor would be expected to run at 105 C, and it is still going strong. Barring mechanical accidents or copper oxidation, there is no reason to assume that it will not keep going indefinitely.

Special Camera Used for Surgical Colorcasts

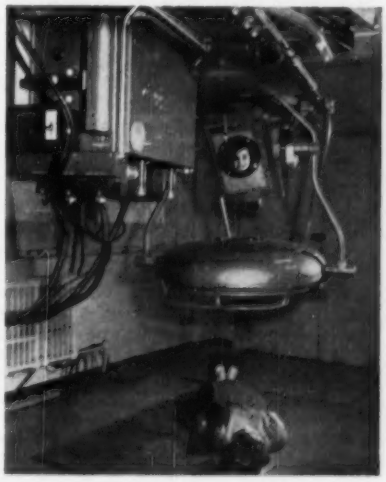
Commercial production of the first compatible color television camera system specifically designed for medical use has recently been announced by the Radio Corporation of America (RCA).

Engineered for completely remote operation and maximum operating economy, the RCA medical television camera is expected to be used in hospitals and medical centers, colleges and universities, and research institutions for origination of live closed-circuit or on-air colorcasts of surgical, medical, and educational instruction and demonstrations, according to E. C. Tracy, manager, RCA broadcast and television equipment department.

Deliveries of the first medical television camera (*TK-41*) units were made to Walter Reed Army Medical Center, Washington, D. C.; Smith, Kline and French Laboratories, Philadelphia, Pa., pharmaceutical firm; and the University of Michigan Medical School, Ann Arbor, Mich. Other orders are being accepted for Spring delivery.

The electronic development is of major significance to medical research and education and makes available to the medical and educational instructor an important new classroom aid which combines the immediacy of television, the realism and detail of compatible color, and the quality performance of broadcast equipment with its own specially developed features for maximum operating flexibility and economy.

The medical camera is designed around three vidicon camera tubes and special electronic circuitry which make possible televising surgical procedures in full-color detail under normal operating-room lighting. It measures only 26 by 15 by 14 inches, weighs less than 200 pounds and, to eliminate interference with surgery or demonstrations, is designed for permanent installation in an overhead fixture which supports both camera and surgical lamp.



COLOR television camera system for medical use eliminates interference with surgery or demonstrations and is installed in overhead fixture supporting camera and surgical lamp.

The new design approach in the medical camera provides users with long periods of exposure to a single scene without danger of image burn-in, and virually eliminates "halo" or overloading effects caused by reflections from polished instruments or wet tissue.

New operating flexibility and detail are provided by the camera's "overhead" design, which keeps the camera out of interference range of the surgeon or instructor, yet permits unrestricted viewing freedom. Horizontally mounted, the camera peers into a mirror which reflects the optical path downward through an opening in the surgical lamp. Remotely controlled, the mirror can be panned and tilted to change the viewing field without moving camera or lamp. If the lamp is moved, the camera's optical path automatically moves to coincide with the change in lighting path.

The camera's complete remote-control design permits one-man operation of the entire camera system, including camara focusing and selection of lenses, as well as operation of the camera mirror. A lens turret accommodates four different lenses, for long, medium, short, and close-up viewing. In cases of surgery confined to a tiny area, such as the eye, optical magnification of the televised area can be obtained by selection of lenses with long optical focus.

The *TK-41* camera also can be incorporated into a microscope system for direct televising of microscopic specimens, enabling a single instructor to display full-color microscope enlargements to an entire class or to groups of classes tied into a closed-circuit network. The camera can be used with virtually all general purpose laboratory microscopes.

The fully compatible color television camera system, in addition to closed-circuit applications, can be used to feed programs to local or television network facilities for broadcast transmission.

It was pointed out that the system's remote control room can be located as far as 500 feet from the camera. All necessary studio control equipment is housed in a master control console.

Ionospheric Studies To Be Made in Antarctica

With their departure for the Antarctic Continent, eight scientists completed the last lap of an intensive training program at the Boulder Laboratories of the National Bureau of Standards (NBS).

Recruited from laboratories across the United States and even one foreign country, the scientists will operate five widespread NBS research stations at the bottom of the world.

They will be at their snowbound stations for at least one year, and the men at each post will collect continuous data with a complicated electronic instrument called the *C-4* ionosphere recorder. Their scientific objective will be the ionosphere—a series of electrified air layers 50 to 250 miles above the earth.

Simply stated, the *C-4* works by beaming

short pulses into the upper atmosphere and measuring the time required for them to travel there and back. A range of from 1 to 25 megacycles is covered in 15 seconds. This process is repeated automatically at least every 15 minutes.

The same kind of ionospheric observations will be made by scientists working simultaneously in more than 75 such stations located throughout the world as part of the International Geophysical Year (IGY) program.

By analyzing the total data, scientists expect to learn much about the height and characteristics of the upper air layers which act much like a huge restless sea, changing from hour to hour, day to day, and season to season.

Interest in these ionized layers stems largely from their unusual ability to reflect radio signals. Changes within them sometimes have a freakish effect on radio communication—transmitting television and FM broadcasts startling distances or causing fadeouts over large areas.

During their stay in the Antarctic, the scientists will have an unusual opportunity to study auroral displays, solar outbursts, and geomagnetic as well as ionospheric storms—all conditions that disturb the ionized layers.

Supervising ionospheric operations in the Antarctic will be H. J. Bengaard, former electrical engineer with the Danish Post and Telegraph Administration, who also will be in charge of the Little America station.

His assistant will be Lt. Col. C. O. Wyman, Philadelphia, Pa., retired communications and electronics officer in the U. S. Marine Corps.

Virgil Barden, Colorado Springs, formerly radio technician at the White Sands Proving Ground Ionospheric Station will be at Byrd Base in charge of ionospheric observations.

J. B. Brown, former physicist with E. I. du Pont de Nemours Co. (Inc.), Bloomington, Del., will be at the Weddell Sea station. Accompanying him will be Donald Skidmore, former electronic engineer with the National Company, Malden, Mass.

Garth Stonehocker, previously physicist with the Glenn L. Martin Company, Baltimore, Md., and Robert Long, Rochester, N. Y., 1956 physics graduate of Dartmouth College, will be at the Knox Station.

W. S. Hough, electronic engineer at the Boulder Laboratories, will leave for the South Pole Station, located at the exact geographical bottom of the world.

New ARDC Disclosures Made

Photo Processor. A unique photographic machine that controls individual development of each negative on a long roll of film is now ready for use by the U. S. Air Force. It examines each negative on a 200- to 400-foot roll of aerial film, individually judges the amount of development required, and develops it to get maximum aerial reconnaissance data. The processor is sealed and can operate in daylight. The exposed roll of film from a reconnaissance mission is loaded into the processor and threaded over rollers which guide it through the development process at five feet per minute. It can be disassembled and transported by air to advance bases.

Computer Speeds Missile Data. Civilian engineers at the U. S. Air Force Missile Test Center at Cocoa Beach, Fla., have created a computing device which, electronically speaking, has a memory of 4,096 words of 48 "bit" capacity. Called FLAC (Florida Automatic Computer), it has been integrated into the missile instrumentation system and serves as the central element in a facility for the reduction of large quantities of missile flight test data. It produces answers to problems in a small fraction of the times necessary formerly.

Improved "Weather Station." A greatly improved "weather station" which is ejected from an airplane to determine weather characteristics in inaccessible parts of the world has been developed. This instrument is a radiosonde, which is more accurate and adaptable than its predecessor and is less costly, as well. It has been designed for use from altitudes up to 60,000 feet and at speeds up to Mach 0.98 (Mach 1.0 is the speed of sound) as compared to the 30,000-foot, Mach 0.43 limit on the older model. In addition, the new unit is 95 per cent reliable as compared with a previous reliability of 80 per cent. The new unit has been flight tested for more than two years and is now being standardized for use throughout the U. S. Air Force.

Printer Plotter Translates Computer Language

An ultrahigh-speed printer-plotter device that can translate the lightning fast language of an electronic computer into easily read printed records as fast as the "brain" can calculate is being successfully used here to process ballistic missile test data.

Believed to the first "read-out" device to match the speed of a computer, the printer-plotter was developed by Burroughs Corporation for the Ballistics Research Laboratories for Army Ordnance. It is known as BEPOC (Burroughs Electrographic Printer-Plotter for Ordnance Computing).

BEPOC was designed as part of an automatic data handling system capable of accepting the high speed output of a computer directly. Ordinarily computer information is "read out" through a buffer, such as a magnetic tape storage system, that holds the information until conventional printers can print it.

Used in connection with ORDVAC, the Proving Ground's Ballistic Research Laboratory computer, BEPOC actually operates as a high-speed page printer in translating the computer's words into printed plotting positions and alphameric information on continuous rolls of ordinary page-width paper at a speed of 300 plotting points per second.

On test in the laboratory here since last June, BEPOC also automatically prints legends and graph lines while translating and printing ORDVAC's output. Reproduction of the BEPOC record is obtained by using translucent paper and ordinary blueprint machines.

As used here BEPOC is a general purpose data recording device that, according to laboratory experts, has exceeded requirements. It is one application of an electrographic recording technique as developed by Dr. Herman Epstein, Burroughs research scientist. A laboratory model of the device has printed 5,000 characters per second serially in tests.

BEPOC uses a three-stage operation to produce its printed record. Characters, plotting positions, and alphameric information first take the form of a pinpoint pattern of electrostatic charges on the surface of low-cost paper as the information comes from the computer.

Next, the pattern is made visible by passing the paper through a dry ink bath. Tiny amounts of the ink cling to the electrically charged pinpoint areas. The paper then rolls across a temperature controlled hot plate that "fixes" the ink permanently, making it fadeproof and smudgeproof.

The pinpoint pattern is made by passing short bursts of electric current through selected wires in a small matrix. Selection of the proper wires forms successive character or numerals. Each image is formed on the paper in approximately three-millionths of a second.

Research experts term BEPOC "the first real advance in a computer output device," It is pointed out that although BEPOC so far has been confined to test work on existing ballistic missile data, it could be applied to actual "in flight" data and produce a second-by-second record of a missile's flight giving its position, operating characteristics and environment conditions.

Consideration is being given to using BEPOC in conjunction with ORDVAC to process data from the 80 rockets to be fired at Ft. Churchill during the United States participation in International Geophysical Year experiments. Plans are also being considered for processing of data from the nation's first earth satellite through the computer and BEPOC.

Awards Established for Welded Design Achievements

Two new awards for outstanding accomplishments in welded designs have been announced by the American Welding Society (AWS). They have been established by A. F. Davis, vice-president and secretary of the Lincoln Electric Company, and will be known as "The A. F. Davis Silver Medal Awards."

A silver medal and a suitable certificate will be awarded annually to each author of the paper selected by the AWS Committee on Awards as the best contribution to the progress of welding in the field of structural design. A similar silver medal and certificate will be awarded to each author of the best paper in the field of machine design.

To be eligible for the award the paper must be written by either one or two authors and be published in *The Welding Journal* in the 12-month period ending with the December issue. The initial award period will cover the 1957 calendar year.

The awards will be presented to the recipients at the annual meeting of the American Welding Society.

Automatic Light Compensating TV Camera

Television cameras that literally "don't care if the sun don't shine" will use a system developed at Temco Aircraft Corporation's Dallas, Texas, plant. Changing light conditions encountered by unattended industrial television cameras are compensated for by the device.

The system, called an "automatic light compensation system," changes the voltage fed to the vidicon camera tube according to the illumination falling upon the scene being televised.

Previous versions of automatic controls for unattended television cameras involved mechanically changing the lens opening by means of a servo motor geared to the iris diaphragm. Disadvantages of this type of control are bulkiness, long response time, and an excessive drain on the power supply.

By varying the voltage driving the camera tube to fit existing light conditions, it is unnecessary to alter the lens aperture setting. A constant output video signal is maintained from the vidicon tube regardless of the light conditions at the time. In effect, the sensitivity of the tube is modified to fit existing lighting, much as the iris of the human eye adjusts the amount of light striking the retina.

Accuracy of the voltage-varying system is within 1% over an incident light change ratio of 200 to 1.

Commercial applications of unattended television circuits include shoplifter surveillance in department stores, production line monitoring, and industrial operations too hazardous for human attention. Military applications include adjusting artillery fire and other tactical reconnaissance from data obtained from television camera drone aircraft and in missile guidance systems.

Hydroelectric Dam Construction Data

Details of a broad range of cost-saving devices and new methods in the construction of hydroelectric installations will be made available to interested experts as a result of a meeting of specialists held recently in Geneva, Switzerland. The meeting, sponsored by the United Nations Economic Commission for Europe's (ECE) Electric Power Committee, examined 43 reports prepared by experts from Spain, Finland, Greece, Italy, Portugal, Federal Republic of Germany, Sweden, Turkey, USSR, Austria, Romania, Czechoslovakia, and the United States. Many of the papers were illustrated with slides, charts, diagrams, and photos. They dealt with the characteristics of hydroelectric power stations constructed in various countries since World War II, on advances and future prospects in the construction of hydroelectric power stations through better organization and mechanization, and on construction methods saving cement, metal consumption, and manpower. A number of films on various phases of dam construction were shown during the meeting.

General rapporteurs were appointed to prepare statements covering the reports submitted for each section as well as the discussion which followed. A volume containing the statements, and summaries in the three working languages of the ECE—English, French, and Russian—of all the reports which were presented, will be issued shortly.

The meeting of specialists proposed that the Secretariat draw up a bibliographical index of works published in the field of hydroelectric construction and installations with a brief abstract accompanying each title.

There were some 60 representatives at the meeting which was held in mid November. They were delegates from Austria, Belgium, Czechoslovakia, Federal Republic of Germany, Finland, France, Greece, Italy, Romania, Spain, Sweden, Switzerland, Turkey, the Union of Soviet Socialist Republics, the Eastern Zone of Germany, the United States of America, and Yugoslavia. The International Labour Organization was also represented.

Summer Studies and Various Special Fellowships

Stanford University. High school mathematics teachers will have the opportunity to study new aspects of their subject and its applications in science and industry under a summer fellowship program established at Stanford University by the General Electric Company (GE).

GE will pay all expenses, including transportation, board and room, tuition, and fees for 50 fellows from Arizona, California, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, North Dakota, Oregon, South Dakota, Utah, Washington, and Wyoming. Instruction will begin late in June and last six weeks. The program is intended to deepen the knowledge of mathematics teachers in high schools and increase their awareness of the role their subject plays in contemporary civilization.

It is hoped their new knowledge and interest will be transmitted to their students and will influence many of them to seek careers in mathematics. In view of the serious shortage of mathematicians, it would be a valuable result of the program.

In addition to classroom work, fellows will take field trips to GE laboratory and manufacturing facilities in the San Francisco Bay area where they will see mathematics at work.

Stanford mathematics professors will teach regular classes. Special lectures will be given by General Electric management, scientific, and engineering personnel.

Three courses will be given. The first will broaden the teacher's background by giving him a working knowledge of number theory, projective geometry, and other fields bordering on high school subjects. The second will deal with fundamental concepts of calculus. The third, a seminar in the philosophy and methods of problem solving, will enable the teacher to challenge the curiosity of his students and to develop in them a scientific frame of mind.

Stanford's is the sixth summer fellowship program, the first in a western university, to be established by General Electric Educational and Charitable Fund for high school teachers of mathematics, chemistry, or physics in major United States universities. Some 300 fellows from 38 states and the District of Columbia will participate next summer. In the 13 years through 1957, the program will have enrolled 1,900 high school teachers.

The company's total educational support, in addition to summer fellowship programs, will finance graduate fellowships, loans, scholarships, equipment for laboratories, the corporate alumnus program under which alumni contributions are matched dollar for dollar, and other grants.

Applicants for the Stanford summer program must be experienced secondary mathematics teachers who intend to remain in the profession. They must hold at least a bachelor's degree, including undergraduate preparation in mathematics. Full information and application blanks have been distributed by the university to high schools in the 14 states.

Harvard University. Forty-five high school teachers who either are currently giving instruction in science or are capable of being converted to science teaching will study at Harvard University next year under a program made possible by a grant of $259,000 from the National Science Foundation (NSF). They will takes courses in four major fields—mathematics, chemistry, biology, and physics—which will be given by scientists in the faculty of arts and sciences, as well as education courses given by the graduate school of education. Fellows may also take other science courses if they wish.

The grant to Harvard is one of 16 which the NSF is making to colleges and universities in this country in an effort to strengthen science teaching in secondary schools. The 16 grants total $4,065,000 and are for one year. About 750 high school science and mathematics teachers will be enrolled, nationally, in the programs.

Recipients of these fellowships at Harvard will each receive stipends of $3,000 plus $300 allowances for each dependent up to four dependents, a $50 book allowance, and travel expenses up to $160. Under the program it is possible for a fellow to receive as much as $4,400, none of which will be spent on tuition.

Recipients of the fellowships will be selected from applicants from public, private, and parochial schools in the 7th through 12th grade bracket. The program will attempt to attract experienced secondary school teachers of science from communities across the nation, other secondary school teachers who may become science teachers, and younger teachers who show unusual promise of leadership but who need additional training in science.

A useful by-product of the program will be to demonstrate the level of introductory collegiate courses in these fields (mathematics, physics, chemistry, and biology, thereby helping the teacher to plan instruction to prepare their most promising students to achieve advanced placement upon entering colleges.

The primary purpose of the grants is to set up experimental programs designed to assist colleges and universities in their efforts to improve the subject matter of high school science teaching, to better instruction, and "to strengthen the capacity of these teachers to motivate students to consider careers in science and to bring these teachers into personal contact with the highly productive scientists who make up the staffs" of the grant-receiving institutions.

Massachusetts Institute of Technology. Leading companies in the United States were asked to nominate their most promising young executives for Sloan Fellowships

for study in the Massachusetts Institute of Technology (MIT) school of industrial management in 1957.

As recipients of Sloan Fellowships, those selected in this nation-wide competition will attend the 20th Executive Development Program which begins in June 1957, at MIT. The awards are considered among the high honors which can come to young men entering on executive responsibilities in American industry.

In a full year at the MIT school of industrial management, ending June 1958, the fellows will study in depth the fundamentals that underlie sound management action. Many will complete requirements for the school's master of science in industrial management degree.

Each Sloan Fellowship carries with it a financial award which helps to meet each fellow's expenses in participating in the program. Each candidate for a fellowship must be nominated by and must have from his employer the promise of financial support for the year.

The Sloan Fellowship awards are made by MIT through a special grant from the Alfred P. Sloan Foundation, Inc., which also makes available funds to help meet the MIT's costs in devoting major educational resources to the Sloan Executive Development Program. The men—and their companies—confirm that this 12-month experience enhances their ability to work effectively with people and problems and strengthens their sense of long-range affiliation with their own companies and with the objectives of a free-enterprise economy.

On arrival at MIT in June 1957, fellows enter preliminary study of management and economic problems. Building upon this foundation, work in the fall and spring terms, ending in June 1958, will cover such topics as management operations (accounting control, marketing, and production), economics and finance, industrial relations, public policy, administrative policy, social science (foreign policy, American law, and industrial history), human relations (group relations, human relations in industry, and executive behavior), and some philosophical aspects of managerial theory.

Throughout the year there will be technical seminars, at which members of the science or engineering departments at MIT meet with the fellows to discuss new technological developments in their fields of importance to management. In addition, each week members of the program will meet at dinner and for an after-dinner seminar with a business leader substantially senior to them and to their normal close associations in industry. During the year there will be four tours to industrial centers of major interest.

Recipients of Sloan Fellowships for 1957-58 will be selected by the school of industrial management on the basis of such evidence as: their records of accomplishment in their own fields and specialties, personal qualities appropriate to high-level management responsibilities, intellectual capacity, and assurance of opportunity to progress into greater leadership.

Sloan Fellowship application forms and further information may be obtained from Professor H. W. Johnson, Director of the Executive Development Programs, MIT School of Industrial Management, 50 Memorial Dr., Cambridge 39, Mass.

LETTERS TO THE EDITOR

INSTITUTE members and subscribers are invited to contribute to these columns expressions of opinion dealing with published articles, technical papers, or other subjects of general professional interest. While endeavoring to publish as many letters as possible, Electrical Engineering reserves the right to publish them in whole or in part or to reject them entirely. Statements in letters are expressly understood to be made by the writers. Publication here in no wise constitutes endorsement or recognition by the AIEE. All letters submitted for publication should be typewritten, double-spaced, not carbon copies. Any illustrations should be submitted in duplicate, one copy an inked drawing without lettering, the other lettered. Captions should be supplied for all illustrations.

Determining Temperature Rise

To the Editor:

The ultimate temperature rise of a coil or machine under constant loss and cooling conditions may be determined by making two observations of temperature rise, and it may be possible to use this result to establish a good estimate of a rating.

Let t_1 and $t_2 = 2t_1$ be the elapsed times from the start of the test, and let T_1 and T_2 be the corresponding observed temperature rises; then the final temperature rise F is given by

$$F = \frac{T_1}{2 - \left(\frac{T_2}{T_1}\right)} = \frac{T_1^2}{2T_1 - T_2}$$

The temperature rise equation is of the form $T = F(1 - \epsilon^{-kt})$. Under the specified test conditions, the data will substitute in the above equation to give exponents of $-kt$ and $-2kt$. This will permit solving for the exponential term by use of the quadratic formula, giving two solutions. One of these is sterile, as it gives the infinite temperature rise on the negative end of the curve. The other solution, substituted back into the equation for either T_1 or T_2 will give the foregoing result. (A copy of the solution will be mailed on request.)

It is assumed, of course, that the parameters are constant and, if high accuracy is desired, it may be necessary to consider the effects of increasing resistance due to temperature effects, or to increased air circulation from the same reason. However, excepting for such secondary factors, the formula is based on rigorous mathematics, with no approximation involved. It is also applicable to any situation described by the exponential equation given such as simple transients of any type.

If it should be desired to evaluate the $-kt$ term, use may be made of a converging series, noting that if $T_2/T_1 = 2$ the curve is a straight line and no longer the exponential.

Let $R = \left(\frac{T_2}{T_1} - 2\right)$

$$-Kt = \log_e\left(\frac{T_2}{T_1} - 1\right) = R - \frac{R^2}{2} + \frac{R^3}{3} - \frac{R^4}{4} \cdots,$$

(All terms in the series become negative)

As an example of establishing an estimated rating from such a test: Using a known overload to shorten the test, assume that a current of 2 amperes gives an indicated ultimate rise of 80 C, and that a 40 C rise is desired. Inasmuch as the heating varies as I^2r, the desired maximum current should be 1.414 amperes.

CLAIR F. BOWMAN (AM '24, M '30)

(Gonzaga University, Electrical Engineering Department)

Technology and Philosophy

To the Editor:

The article "VDI Celebration Commemorates 100 Years of German Engineering" by R. W. Sorenson brings home, rather forcefully, to me the need for the engineering profession to broaden its base. I think the AIEE can contribute a great deal in the following way.

Dr. Sorenson, as well as other U.S. delegates, was apparently impressed by brilliant discussions on the relationship of philosophy, religion, and technology as viewed from the human side. In fact, he made a significant comment that "it was interesting to note that throughout the whole program there was much attention given the relation of religion, philosophy, psychology, and human relations to the practice of engineering."

In *Electrical Engineering* it is apparent to me that you recognize the need for achieving a reasonable balance between technology and philosophy in the subject material. Possibly Dr. Sorensen has uncovered a fertile field on the latter subject. Should we include translations of such papers as "Man and His Technology" by Professor Dr. Pfender, Professor Dr. R. Viewig's welcoming address on the subject of the relation between science and practical technology, and Dr. H. H. Kumpke's discussion on the social effects of technology in future issues of *Electrical Enginering?* More than likely there are similar types of articles published by scientists and engineers in foreign countries.

It is my opinion that American technology could advance materially if our "gadgeteering" was infused with philosophy. The engineering societies can contribute by including overseas material on this subject in their journals.

Very truly yours,

JOHN L. CAMERON (AM '53)

(Department 61-30 Lockheed Aircraft Corporation, Missile Systems Division)

NEW BOOKS

The following new books are among those recently received at the Engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question.

A C SWITCHGEAR. Volume 1. A Survey of Requirements. By J. R. Mortlock. Chapman & Hall Ltd., London, England, 1956. 387 pages, 5-1/2 by 8-3/4 inches, bound. 50s. Designed to aid engineers in solving some of the problems associated with determination of ratings of switchgear, this volume deals with methods of carrying out fault study, methods of limiting fault currents, and principles of operation of different types of protection and relays. Voltage aspects of the problem of ensuring correct operation of protective gear also are treated in chapters devoted to the initiation of arcs, restriking voltage, and insulation. The second volume will deal with details of switchgear and basic design principles.

ADVANCES IN ELECTRONICS AND ELECTRON PHYSICS. Volume 8. Edited by L. Marton. Academic Press Inc., Publishers, 111 Fifth Ave., New York 3, N. Y., 1956. 562 pages, 6 by 9-1/4 inches, bound. $15. The present volume in this series contains extensive critical reviews covering the following subjects: molecular beam techniques and applications, field emission, mass spectroscopy, amplitude and time measurement in nuclear physics, pulse amplitude analysis, electron guns and focusing for high-density electron beams, electrical life of oxide-cathode receiving tube, viewing storage tubes, and magnetron mode transitions. References are listed at the end of each review.

ANALYSIS OF BISTABLE MULTIVIBRATOR OPERATION. (The Eccles-Jordan Flip-Flop Circuit) By P. A. Neeteson. Philips Technical Library, Eindhoven, Holland, 1956. 82 pages, 6 by 9 inches, bound. $2.15 (postpaid). A treatment of an electronic switching circuit, using pulse techniques, which has found applications in computers, counters, radar, telemetering, and other fields. The author analyzes the circuit both in static and dynamic conditions, giving such operating characteristics as triggering speed and sensitivity. Covers design of the fundamental circuit and its variations, with necessary calculations given in appendixes.

BIBLIOGRAPHY AND ABSTRACTS ON ELECTRICAL CONTACTS. (1955 Supplement) (Special Technical Publication No. 56-J). American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa., 1956. 41 pages, 6 by 9 inches, paper. $1. This supplement includes 168 references for the years 1954 and 1955, and 16 new references picked up for the years 1945-1953. Contact materials, circuit breaker design and testing, relevant aspects of circuit theory, contactor or relay design, and the various types of contacts are the major subjects covered by the references. The abstracts, for the most part, have been reprinted from such sources as *Science Abstracts* and *Engineering Index*.

ENGINEERING MATHEMATICS. By K. S. Miller. Rinehart and Company, Inc., 232 Madison Ave., New York 16, N. Y., 1956. 417 pages, 6 by 9-1/4 inches, bound. $6.50. This text for the first year of graduate work in engineering deals with the following topics: determinants and matrices; special subjects in integration such as the Gamma function, the error function, and Euler's constant; linear differential equations; Fourier series and integrals; the La Place transform; network theory; and probability, with emphasis on functions of random variables. The main text is supplemented by appendixes dealing, at a somewhat higher mathematical level, with Borel sets, the Riemann-Stieltjes integral, and Fourier series and integrals.

FIXED CAPACITORS. (Radio and Electronics Components, vol. 3) By G. W. A. Dummer. Sir Isaac Pitman & Sons, Ltd., London, England, 1956. 260 pages, 5-1/2 by 8-3/4 inches, bound. 45s. This is a concise treatment of the fundamental characteristics and uses of a wide range of types of capacitors, including electrolytic, air-dielectric, vacuum, and gas filled as well as those using mica, paper, glass, ceramic, plastic, and loaded-plastic dielectrics. There are some 370 references in the accompanying bibliography.

AN INTRODUCTION TO CYBERNETICS. By W. Ross Ashby. John Wiley & Sons, 440 Fourth Ave., New York 16, N. Y., 1956. 295 pages, 5-1/2 by 8-3/4 inches, bound. $6.50. The basic ideas of cybernetics are treated in this book without reference to electronics and using no mathematics beyond elementary algebra. Part I, devoted to the principles of mechanism, deals with stability, feedback, coupling, and statistical methods for analyzing large and complex systems. Part II uses the methods developed in the first part to show what information is and how it is coded. The third and last part discusses mechanism and information as they are used for regulation and control in biological systems and provides the foundations for a general theory of complex regulating systems.

INTRODUCTION TO ELECTRICAL ENGINEERING. By G. V. Mueller. McGraw-Hill Book Company, 330 W. 42nd St., New York 36, N.Y., third edition, 1956. 466 pages, 6-1/4 by 9-1/4 inches, bound. $7.50. As in previous editions, this text presents the fundamental principles of electric and magnetic circuits and fields. Introductory material on electronics, transient states, dielectric circuits, and electrochemistry is also included. New material in this edition covers transistors, magnetic amplifiers, the piezoelectric effect, magnetostriction, and several specialized types of electron tubes; and the order of presentation of topics has been rather considerably changed.

ION EXCHANGE AND ITS APPLICATIONS. (London University Conference, April 1954) Published 1955 by Society of Chemical Industry, London, England. Available from The Macmillan Company, 60 Fifth Ave., New York 11, N.Y. 173 pages, 8-1/2 by 11-1/8 inches, bound. $7.50. This volume contains 20 papers dealing with the structure, synthesis, and general properties of ion-exchange resins, the operation of ion-exchange columns, and applications such as in water treatment, the metallurgical industries, and various purification processes. One paper deals with the preparation of drinking water from brackish water or sea water by electrodialysis.

KRISTALLODEN-TECHNIK. By R. Rost. Wilhelm Ernst und Sohn, Berlin, Germany, first supplement to second edition, 1956. 87 pages, 5-3/4 by 8-3/8 inches, bound. DM 12.90. This supplement to the recent second edition of the text by the same authors and the same title gives further descriptions of various types of high-frequency transistors, some new applications, and characteristics and circuits of a number of additional actual commercial products.

LABORATORY ADMINISTRATION. By E. S. Hiscocks. St. Martin's Press, 103 Park Ave., New York 17, N. Y., 1956. 392 pages, 5-1/2 by 8-3/4 inches, bound. $8. In this book, the Secretary of the National Physical Laboratory in Great Britain examines the requirements in the organization and management of research laboratories which will provide the conditions in which scientific work can be most productive. Concerned with both governmental and industrial laboratories employing more than 200 people, the book deals with the functions of the director and the staff, recruitment, salaries, finance, technical services, buildings, training for management, and other matters, related to the day-by-day running of a research establishment. Some data on costs are given.

THE PHYSICS OF NUCLEAR REACTORS. (British Journal of Applied Physics, Supplement no. 5) Institute of Physics, London, England, 1956. 111 pages, 8 by 10-3/4 inches, boards. 25s. This conference was held as a means of informing physicists and engineers of recent advances in nuclear reactors and of problems needing solution. The 13 papers, with discussion, published in this supplement deal with the physics of experimental and advanced reactors; recent developments in nuclear theory; reactor shielding, control, and instrumentation; the role of chemistry and metallurgy in a nuclear energy project; and the effects of irradiation on the physical properties of solids. One paper is devoted to the zero-energy fast breeder reactor, Zephyr, and two to descriptions of Canadian and British research reactors.

PROGRESS IN SEMICONDUCTORS. Volume 1. Edited by A. F. Gibson and others. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y., 1956. 220 pages, 5-7/8 by 9 3/8 inches, bound. $8. The first in a new series of annual volumes containing review articles by specialists in the field. The present volume consists of seven papers covering advances in silicon, the germanium filament, the Seebeck effect, electrical properties of phosphors, transistors for high frequency operation, the photo-magneto-electric effect, and the field effect. References are listed after each article.

RADIO TELEMETRY. By M. H. Nichols and L. L. Rauch. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y., second edition, 1956. 461 pages 5-7/8 by 9-1/4 inches, bound. $12. A summary of the available unclassified material on theory, methods, and techniques. The first part, designed for those who desire a general understanding of fundamentals, covers noise and errors, modulation and multiplexing, data interpretation, radio links, and instruments. Part two is a thorough development of certain aspects of the theory: modulation, multiplexing, and frequency analysis. The third part is a discussion of existing radio telemeters, and the last part, a series of appendixes containing details and calculations. A bibliography is included.

THÉORIE ET TECHNIQUE DE LA RADIOCRISTALLOGRAPHIC. By A. Guinier. Dunod, Paris, France, second edition, 1956. 736 pages, 6 1/4 by 9-3/4 inches, bound. Fr. Frs. 9500. An extensive and comprehensive treatise on X-ray diffraction theory, experimental methods of investigation, and applications. The major part of the book is devoted to normal crystalline solids and powders and single crystals, but imperfect crystals and amorphous substances are also dealt with. X-ray apparatus, the general properties of X-rays, and the fundamentals of crystallography are covered in the early chapters, and a discussion of Fourier transforms is appended. Applications to the fields of metallography, the physics of solids, and other special adaptations are of particular interest to engineers.

YEAR BOOK OF THE HEATING AND VENTILATING INDUSTRY, 1956. Published 1956 by Technitrade Journals Ltd., London, England. 398 pages, 5-3/8 by 8-3/8 inches bound. 10s 6d. Oil firing practice, oil-fired air heaters, panel heating, and electric surface heating of fuel oil lines and storage tanks are discussed in the four papers included in this manual of technical and trade information for engineers and contractors. The remainder of the volume consists of a 25-page annotated bibliography of the British literature published in 1955, a buyers' guide, information on standards and contracts, and a directory of the society.

PAMPHLETS

The following recently issued pamphlets may be of interest to readers of "Electrical Engineering." All inquiries should be addressed to the issuers.

INDUSTRIAL PREPAREDNESS STUDY OF TRANSISTORS AND DIODES. Technical advances in the production of germanium and the semiconductor devices for which it is the nerve center have been reported by the General Electric Company (GE) under contract to the Army Signal Corps. GE's 402-page industrial preparedness study of transistors and diodes, covering the period 1952-55, has just been made available to industry through the Office of Technical Services (OTS), U. S. Department of Commerce. Work on the processing of high-purity germanium brought development of a continuous reduction furnace with an output equal to that of nine batch-type furnaces, a new six-zone refining process, and a resistance-type pulling furnace adaptable to quasi-automation. Equipment and methods were developed to measure bulk parameters for quick, reliable evaluation of metals. In research aimed at mechanization of the diffused junction rectifier, a rectifier package was designed for automatic, all-welded machine production. Production of high-voltage junction rectifiers increased with use of a tunnel oven diffusion process. An automatic machine made possible control of electrolytic etching. A point contact transistor package was developed to utilize all-welded hermetic sealed construction. It was shown that the germanium high current rectifier could be manufactured with a minimum of nondiscretionary tooling. Removal of operator error reduced unit failure from 25 to 10 per cent. The detailed, illustrated report, *PB 121291*, July 1955, may be ordered from OTS, U. S. Department of Commerce, Washington 25, D. C., price $8.

BASIC RESEARCH IN ELECTRONICS. Areas in the field of electronics requiring further basic research in the interest of national defense are discussed in a recently released report of the Department of Defense. The report, prepared by the Department's *ad hoc* working group of engineers and scientists from the military, universities, and research and industrial firms, is available to industry through the Office of Technical Services (OTS), U. S. Department of Commerce. Dis-

cussions in the report are on "Electronic Radiation: Coupling of Energy to Space, Antennas . . . Wave Propagation"; "Generation of Electromagnetic Energy"; "Solid State, Including Magnetic Phenomena"; "Information Theory"; "Plasma, Electron, and Ion Dynamics"; "Atomic and Molecular Resonance"; "Surface Phenomena"; "Data Processing"; "Prime Power Sources"; "Nuclear Radiation Effects on Electronics"; "Materials in Electronics"; "Mathematical Methods"; "Network Theory"; "Underwater Sound"; and "Fundamental Problems in the Field of Acoustics in Air." Guide lines for implementing a sound national basic research program are also listed in the report. The report, *PB 121486*, Ad Hoc Working Group on Basic Research in Electronics, Technical Advisory Panel on Electronics, Office of the Assistant Secretary of Defense for Research and Development, Department of Defense, May 1956, may be obtained from OTS, U. S. Department of Commerce, Washington 25, D. C. It contains 50 pages, price $1.25.

1956 SUPPLEMENTS TO BOOK OF ASTM STANDARDS. To keep up to date the triennially published "Book of ASTM Standards," the American Society for Testing Materials (ASTM), in the intervening years, issues supplements to each part of the book. The 1956 Supplements, issued in seven parts, give in their latest form 420 specifications, tests, and definitions which either were issued for the first time in 1956 or were revised since their appearance in the 1955 Book. The newly issued Supplements are: Part 1, Ferrous Metals; Part 2, Nonferrous Metals; Part 3, Cement, Concrete, Ceramics, Thermal Insulation, Road Materials, Waterproofing, and Soils; Part 4, Paint, Naval Stores, Woods, Sandwich Construction, Building Constructions, Fire Tests, and Wax Polishes; Part 5, Fuels, Petroleum, Aromatic Hydrocarbons, and Engine Antifreezes; Part 6, Rubber, Plastics, and Electrical Insulating Materials; and Part 7, Textiles, Soap, Water, Paper, Adhesives, Shipping Containers, and Atmospheric Analysis. The 1956 Supplements, in heavy paper covers, can be obtained from the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. at $1 per part or $28 for the complete set of seven parts.

ANNUAL BULLETIN OF ELECTRIC ENERGY STATISTICS FOR EUROPE. Published by the United Nations Economic Commission for Europe (ECE), The Bulletin has been compiled at the request of the ECE Electric Power Committee's Working Party on Electric Power Statistics. The current issue contains final data for the years 1938 and 1950-54, as well as provisional data for 1955. The data given is for Austria, Belgium, Bulgaria, Czechoslovakia, Denmark, Eastern Germany, Finland, France, Greece, Hungary, Ireland, Italy, Luxembourg, the Netherlands, Norway, Poland, Romania, Sweden, Switzerland, Turkey, Union of Soviet Socialist Republics, United Kingdom, United States of America, Western Germany, and Yugoslavia. The tables in the publication provide figures for maximum net capacity in continuous operation (situation at December 31 of each); fuel consumed in electricity generation; international exchanges of electric energy during 1955; imports of electric energy during 1938 and 1951-55; exports of electric energy during 1938 and 1951-55; production, international exchanges and gross consumption of electric energy, and average efficiency of thermal plants; and consumption of electric energy. One of the aims of the Bulletin is to give all-European coverage to statistics already published regularly for a limited number of countries, and, at the same time, to broaden the scope of the information published. The definitions adopted by the Working Party, which are those used in the Bulletin, are based, as far as possible, on definitions in current use, and in particular on those adopted by the International Union of Producers and Distributors of Electric Energy (UNIPEDE). All the data contained in the Bulletin have been directly supplied by governments to the ECE Secretariat. 41 pages including 5 tables. Available in bilingual edition, English-French, from the Sales Section, European Office of the United Nations, Geneva, Switzerland, or may be ordered through Sales Agents for United Nations Publications. A Russian edition is to be issued shortly. Price 25¢, 1/9 stg., SW.frs. 1., or the equivalent in local currencies.

TECHNIQUES FOR MAKING AND PROJECTING STEREOSCOPIC SLIDES. With an eye toward potential use of stereoscopic viewing as an aid to research and engineering, the U.S. Air Force has prepared a practical, easy-to-follow guide to the best presentation of stereopictures. The volume is available through the Office of Technical Services (OTS), U. S. Department of Commerce. A handy basic reference for the amateur, the report explains techniques for proper picture-taking, slide mounting for hand-operated or automatic projectors, and stereoprojection. The system is said to work equally well with close-up, medium-distance, or infinity views. Design of a jig for correctly aligning, positioning, rotating, locating, and framing pictures for use in a completely automatic projector is described. The phenomenon of "eyestrain" sometimes experienced by stereopicture viewers is explained briefly. The Air Force anticipates that recent refinements in stereophotographic equipment and the high degree of realism in stereoviewing will bring increasing use of the medium in research and development, and for engineering and records in connection with equipment, maintenance, performance, and unsatisfactory reports. The illustrated report, *PB121282*, C. W. Kendal and W. H. Richards, Wright Air Development Center, January 1956, may be ordered from OTS, U. S. Department of Commerce, Washington 25, D.C. It contains 35 pages, price $1.

THE IBM JOURNAL OF RESEARCH AND DEVELOPMENT. A new scientific magazine, to be published quarterly, was started January 1, 1957, by the International Business Machines Corporation (IBM) 590 Madison Ave., New York, N.Y. Purposes of the *Journal* are to publish original work by IBM scientists and engineers for the largest possible audience of interested technical people, and help to promote more rapid dissemination of scientific and technical information within industry in the United States and throughout the world. The new magazine will publish comprehensive articles on the latest scientific and technical results from IBM research and development laboratories here and abroad. Articles will come from fields as varied as solid-state physics, chemistry, metallurgy, information theory, and electronics. Other articles will treat the latest developments in computers, data processing machines, and design of components such as magnetic core memories and semiconductor devices. It is available by subscription at a cost of $3.50 per year.

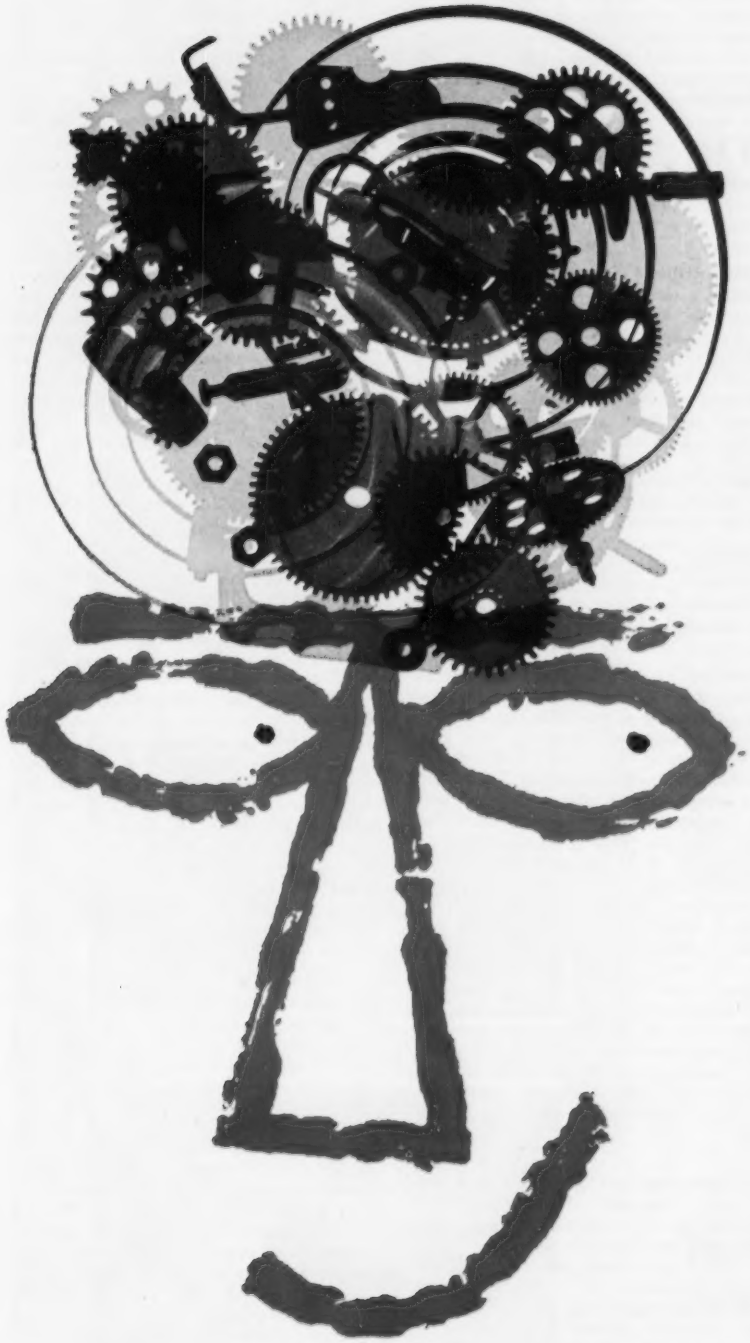
MATHEMATICS AND COMPUTERS. By G. R. Stibitz consultant in applied mathematics, Underhill, Vt.; and J. A. Larrivee, associate professor of mathematics, Worcester Polytechnic Institute. 236 pages. Illustrated. McGraw-Hill. $5. Mathematicians, scientists, and engineers concerned with the relationships between pure and applied mathematics and the growing use of automatic computers should find interest in this newly published volume. It surveys the work of the applied mathematician, the problems he studies, the methods he uses—especially computational methods—and the computing devices that help him in the application of mathematics to problems in science, engineering, and business. Computing devices and their components are described, especially the automatic digital computer, the way it works, and its capabilities and limitations. The nondigital computing devices also are covered. A treatment of the use of randomness in computation, and typical applications of computing devices in technology and business are included. Essentially, the book gives a view of computers as tools of the mathematician, in a treatment ranging through such subjects as the kinds of problems the applied mathematician meets and the concepts to which each is related; high points in the development of two great families of computing aids, from the abacus to the automatic digital computer, and from the slide rule to the differential analyzer; how a variety of mathematical problems can be reduced to successions of simple arithmetical problems, as a step in using digital calculators; how tubes and switches are organized into automatic computers; and how voltages, lengths, forces, and other measureable quantities may represent numbers and be used in computing aids. Further details are available from McGraw-Hill Book Information Service, 327 W. 41st St., New York 36, N. Y.

AN INTRODUCTION TO CYBERNETICS. An explicit guide into the seemingly formidable maze of cybernetics by W. R. Ashby has been published by John Wiley & Sons. Dr. Ashby describes his new book as a "self-instructor," an apt phrase for a volume which defines this field in terms of only elementary algebra and proceeds from commonplace and well-understood concepts. In a step-by-step procedure, the book shows how the concepts can be made exact, and demonstrates how they can be developed to lead into such subjects as feedback, stability, regulation, ultrastability, information, coding, noise, and other cybernetic topics. The book covers first the principles of mechanism, treating such matters as its representation by a transformation, what is meant by "stability" and "feedback," the various forms of independence that can exist within a mechanism, and how mechanisms can be coupled. This section introduces the principles that must be followed when the system is so large and complex (e.g., the brain or society) that it can be treated only statistically, and also explores the system that is not entirely accessible to direct observation—the so-called Black Box Theory. The second part of the book uses the previously developed methods to study what is meant by "information," and describe how it is coded when passing through a mechanism. These methods are applied to various biological problems. Leading into Shannon's theory, this section effects a ready transition into the subsequent study of Shannon's own work. The final section deals with mechanism and information as they are used in biological systems for regulation and control, both in the inborn systems studied in physiology and in the acquired systems studied in psychology. The author shows how hierarchies of such regulators and controllers can be built, and how an amplification of regulation is thereby made possible. A new and simpler account of the principle of ultrastability enters the picture here, laying the foundation for a general theory of complex regulating systems. On the one hand, an explanation is afforded of the outstanding regulatory powers of the brain and on the other, principles by which a designer may build machines of like power. The book contains 295 pages and is priced at $6.50.

COOK TECHNICAL REVIEW, VOLUME 3, NO. 2. Released by Cook Research Laboratories, Division of Cook Electric Company, Chicago 14, Ill. This issue of 28 pages deals with electrohydraulic servo valves. Part I presents basic information relative to the types and characteristics of high response servo control valves. The subsequent part describes the various types of valves which are commercially available and discusses the selection of electrohydraulic servo valves and their system application. A. Johnson, project engineer; L. D. Schmid, senior engineer, and Jay Warshawsky, technical director, Automatic Control Systems Section, all of Cook Research Laboratories, are the authors of this issue of *The Cook Technical Review*. The price is $1.00 per copy in the United States and Canada ($1.25 in other countries). Check should be made payable to Cook Electric Company and addressed to Circulation Manager, 2700 N. Southport Ave., Chicago 14, Ill.

PRINCIPLES OF LABORATORY TEMPERATURE CONTROL ELECTRONIC RELAYS, THERMISTOR OPERATED TEMPERATURE CONTROL. A three-part report of research into devices for laboratory temperature control has been prepared for the U.S. Navy and released to industry through the Office of Technical Services (OTS), U. S. Department of Commerce. Part 1 of the report is devoted to the principles of temperature control in the laboratory. Important factors in the design of water baths are discussed. The most-used types of temperature sensing elements are identified, and circuits are described for electronic relay controls for use with mercury regulators and thermistors. Two types of electronic relays which can be built in the laboratory are described in Part 2. The first uses a lower power pentode or dual triode, and the second a small thyratron. In both relays, the regulator contacts change the grid bias of the tube and carry a current of a few microamperes or less. In Part 3, a thermistor operated controller is described which allows temperature to be set by a dial and controlled to plus or minus 0.01 C or better. A protective mount for use with a thermistor in a water bath is discussed. The report, *PB121120*, C. M. Proctor for Office of Naval Research, March 1955, may be ordered from OTS, U. S. Department of Commerce, Washington 25, D.C. It contains 55 pages, price $1.50.

CATALOG OF LIGHTING DEMONSTRATION AND EXHIBIT MATERIALS. To help the electric utilities meet their needs for aggressively selling the commercial lighting market, the Commercial Lighting Committee of Edison Electric Institute (EEI) has prepared this comprehensive and thorough catalog full of illustrations and information of useful selling tools proved needed by the lighting salesman in the field. Selected props and other materials available in the industry for use in group lighting demonstrations and exhibits are shown, each with an illustration and text, giving a description of the kit and its method of application. The majority of the equipment listed may be purchased outright or rented from the manufacturer. In some instances utilities have designed and constructed their own demonstration units. Thus, the illustrations and accompanying dimensional details will serve to aid those who contemplate building similar pieces. The material listed can be used either for individual or group audiences. Price of the catalog is $1.00 to EEI member companies and $1.50 to nonmember companies and companies out of the United States.



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HIGH INTERRUPTING CAPACITY

Important news: These newly-developed Gibsiloy contacts containing silver and cadmium oxide withstand larger currents than silver or its alloys ... without welding or sticking! They give longer life, greater current-carrying capacities, and higher electrical ratings. They have excellent arc-quenching traits, low contact resistance, high conductivity, and low material loss. Delivery is quick. And cost is comparable to that of fine silver! Many users are switching to Gibsiloy silver and cadmium oxide contacts.

Typical Applications
motor-starting & limit switches
light & medium-duty contactors
light & medium-duty relays
aircraft relays
industrial controls

Properties	Conductivity %IACS	Hardness Rockwell 15T
KA-2	80	40-50
KA-3	75	50-60
KB-2	80	45-55
KB-3	75	50-60

KA is supplied as discs, rectangles, irregular shapes.

KB is supplied as rivets, rectangles, discs (projection-weld-backed), discs (with or without silver solder backing).

Try Gibsiloy KA and KB silver and cadmium oxide contacts to replace silver or silver alloy contacts in your present electrical products. And plan for them in new ones. Their use is already widespread and growing. Let us discuss how KA and KB can help you.

Write for latest folder on Gibsiloy KA and KB and send for Form #23 "Request for Contact Recommendation"

Gibsiloy
ELECTRICAL CONTACTS
Manufactured by
GIBSON ELECTRIC COMPANY
8348 Frankstown Ave. Pittsburgh 21, Pa.

INDUSTRIAL NOTES

Plant Expansion. The continual improvement in Acme Electric Corporation's sales of transformers and the growth in its business of regulated power supply units for electronic computers has necessitated expansion of facilities at Allegany, N. Y. A new building will be erected adjacent to the present Allegany plant and will provide more working space, plus receiving and shipping facilities. The company also operates two plants in Cuba, N. Y. employing about 700 people. When the new plant at Allegany is completed, approximately 200 additional employees will have been specially trained to perform the operations that will be conducted there.

Earth Satellite Component. The development of a computer that will play a decisive role in the U. S. Navy's launching of the Vanguard earth satellite in the summer of 1957 has been announced. The "coasting-time computer" will control the injection of the satellite into its orbit around the earth at precisely the right moment. Ten scientists, under the direction of Dr. W. Harries and Dr. I. Bogner, senior scientists, have been working on the project since the Martin Company, prime contractors, awarded Air Associates, Inc., Teterboro, N. J., the vital subcontract. The coasting-time computer will collect flight data during the first stage and the thrust period of the second stage of the launching procedure.

Hardening of Mill-Length Shafting. An efficient application of high-frequency induction heating is shown in the Thermatool progressive rod hardening mill. Uniform hardening of mill-length shafting to specified hardness and depth is achieved in continuous production with push-button simplicity. Designed and built by New Rochelle Tool Corporation, New Rochelle, N. Y. for metal working shops, it hardens carbon steel rods up to 4 inches diameter and 30 or more feet in length, without distortion, thus eliminating the usual straightening process. The Thermatool mill has a skewed roll arrangement driven by two 1-hp variable-speed motors. The design permits the feed rate and rotation speed of the rods to be adjusted independently of each other. It is the feed rate, rotation speed, as well as the amount of power that determine the depth and degree of hardness obtained in the steel rods.

New Hetherington Plant. Work is under way for a one-story, 16,200 square-foot building for Hetherington, Inc., Hook Road, Folcroft, a suburb of Philadelphia, Pa. The plant will provide urgently needed extra room in all departments to meet the growing demands of the aviation, electrical, and electronic industries. The air-conditioned building will house administrative, sales, and engineering offices as well as testing and assembly departments. Basic parts manufacturing for Hetherington's special-purpose switches and indicator lights will remain in the Sharon Hill, Pa. plant.

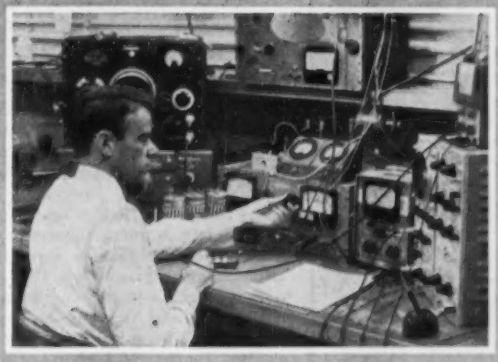
Keuffel & Esser. To expand its production of precision equipment for optical tooling, Keuffel & Esser Co. is opening a new factory at Cranford, N. J. The Cranford plant will be the sixth factory that Keuffel & Esser has added to its manufacturing facilities during the last few years. The 89-year-old engineering company maintains its general offices and largest factory at Hoboken, N. J. This company has been a pioneer in the development of advanced optical instruments for many industries and for military purposes. Its line of optical tooling is the most complete in the world.

West Coast Plant. Magnetic Amplifiers, Inc. wishes to announce the formation of its new West Coast Division. This new plant is located at 136 Washington St., El Segundo, Calif. Engineering and production of magnetic and transistor servo amplifiers, d-c power supplies, voltage regulators, and airborne servo systems will be accomplished at the West Coast facility. The establishment of the new division will facilitate liaison engineering and production of airborne components and systems for the airframe, missile, and electronic industries.

Electric Delivery Truck. A modern battery-powered truck, the *C-F*, which not only performs faster and more efficiently than a gasoline truck on short multiple-stop delivery routes, but also costs up to 50 per cent less to operate, has been developed by the Cleveland Vehicle Company, 3949 Lakeside Ave., Cleveland 14, Ohio. The *C-F* electric street truck starts and picks up more quickly and smoothly than a gasoline truck. Responsible for this performance is the huge-reserve surging power source, one of the latest Exide-Ironclad industrial-type storage batteries. Predicting a probable life potential of twenty years for the truck, the company states that its repair expenses average 55 per cent less than for comparable gasoline trucks.

General Telephone, Chicago. General Telephone Corporation, 260 Madison Ave., New York 16, N. Y. has announced the formation of General Telephone Laboratories, Incorporated, with its headquarters in Chicago, Ill. The newly created organization has acquired the research and development personnel and facilities of Automatic Electric Company, principal manufacturing unit of the General Telephone System, and will embark on a greatly expanded program of basic research and product development in the telephone switching and related communication fields. The work of the new laboratories will also extend into all areas of remote control by electronic and electromechanical means. In addition, the new laboratories will undertake a comprehensive program of quality analysis and measurement for all units of the General Telephone System.

(Continued on page 20A)



RESEARCH AND DEVELOPMENT

PILOT LINE PRODUCTION

FINAL ASSEMBLY

TESTING IN SCREEN ROOM

COMMUNICATIONS at Ramo-Wooldridge

Communications activities at The Ramo-Wooldridge Corporation include research, development, and manufacture of advanced types of radio communication systems, ground-reference navigation systems, and electronic countermeasure systems. Major programs are in progress in each of these fields.

New and unusual techniques have been employed to provide systems having a high order of security in the transmission of information, broad flexibility in combating unfavorable signal propagation conditions, and substantially greater information capacity per operating channel.

Some of the techniques used have made possible an increased range for given levels of transmitter power and reliability of communications. Others have provided specific advantages in very long distance communications or in operational situations requiring unique signaling capabilities. Developments in navigation systems have resulted in new equipment that is suitable for the guidance of aircraft at long ranges from their bases.

In the work currently under way, some systems are in the laboratory development stage, some in the flight test stage, some are in production. Several types of systems developed and manufactured by Ramo-Wooldridge are in extensive operational use.

Openings exist for engineers and scientists in these fields of communications activities:

- Systems study and analysis
- Airborne transmitters
- Transistorized video and pulse circuitry
- Airborne receivers
- Reconnaisance systems
- Digital communications systems

The Ramo-Wooldridge Corporation

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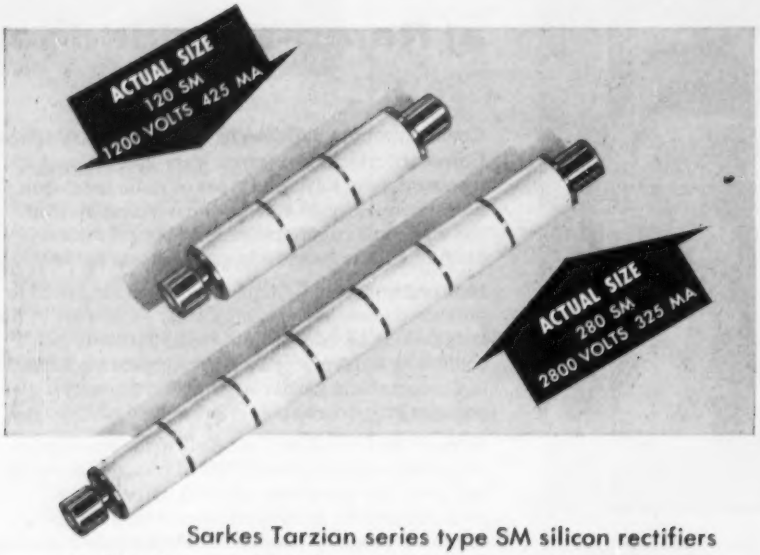
Your Demands Created

HIGH VOLTAGE
SILICON POWER RECTIFIERS



Sarkes Tarzian series type SM silicon rectifiers provide the practical, low cost solution to the high voltage silicon rectifier problem. Stable characteristics inherent in low voltage junctions are carried over to this series. If your application calls for high temperature and high voltage, send for complete information.

ELECTRICAL RATINGS

S.T. Type	Max. Peak Inverse Volts	Max. RMS Volts	Current Ratings—Amperes: Max. D.C. Load 100°C	Max. D.C. Load 150°C	Max. RMS 100°C	Max. RMS 150°C	Max. Recurrent Peak 100°C	Max. Recurrent Peak 150°C	Surge 4MS Max. 100°C	Surge 4MS Max. 150°C	Jetec No.
80SM	800	560	.450	.225	1.12	.560	4.5	2.25	27.0	13.5	1N1108
120SM	1200	840	.425	.212	1.06	.530	4.25	2.12	25.5	12.7	1N1109
160SM	1600	1120	.40	.200	1.00	.500	4.00	2.00	24.0	12.0	1N1110
200SM	2000	1400	.375	.187	.940	.470	3.75	1.87	22.5	11.2	1N1111
240SM	2400	1680	.35	.175	.875	.437	3.50	1.75	21.0	10.5	1N1112
280SM	2800	1960	.325	.162	.812	.405	3.25	1.62	19.5	9.7	1N1113

DIMENSIONS

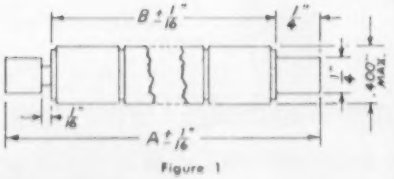


Figure 1

Figure 1 A	Figure 1 B	JETEC NO.
1-15/32"	31/32"	1N1108
1-15/16"	1-7/16"	1N1109
2-13/32"	1-29/32"	1N1110
2-7/8"	2-3/8"	1N1111
3-11/32"	2-27/32"	1N1112
3-13/16"	3-5/16"	1N1113

Sarkes Tarzian INC

RECTIFIER DIVISION

415 N. College Ave., Dept. E-1, Bloomington, Ind.

IN CANADA: 700 WESTON RD., TORONTO 9, TEL. ROGERS 2-7535
EXPORT: AD AURIEMA, INC., NEW YORK CITY

(Continued from page 18A)

Industrial Notes

Automation Contract. Contracts for automatic assembly machines have been awarded by International Business Machines Corporation (IBM) to Multra Corporation, Stamford, Conn., a subsidiary of Barnes Engineering Company. The contracts call for the design and construction of a Multra automatic assembly machine that will automatically sort, feed, and assemble the parts of an IBM electrical relay, plus collateral development contracts. The relay is a standard part of the IBM electric accounting machines, as well as IBM computers. The relay consists of nine parts: a frame, two springs, an armature, coil, adjusting plate, and three screws. All parts are automatically sorted, fed, and inserted by the Multra machine. Other contracts awarded Multra Corp. by IBM call for exhaustive studies in automatic feeding of various sizes and shapes of parts, prior to their automatic assembly.

Network Analyzer Rental Service. The network analyzer installation is now available to public utility companies, manufacturing industries, and consulting engineers for their use in making power system studies. Fast operation, accuracy, and minimized advance preparation recommend this unit for completing complex problem solutions in short time. Quiet, air-conditioned quarters, designed for the purpose, aid in efficient operation. The analyzer is capable of simulating any electrical system which may be represented by 12 generators, 88 lines, 32 loads, 16 transformers, and 150 buses. The nominal per diem rental fee includes the services of an operator and an assistant. Location is in downtown Philadelphia, convenient to transportation and hotels. For time available, contact either the nearest I-T-E district office or I-T-E Circuit Breaker Co., Philadelphia 30, Pa.

RCA Weather Radar in Australia. Qantas Empire Airways, Ltd., of Australia, will equip its fleet of transoceanic passenger planes with (Radio Corporation of America) RCA weather radar. Twenty-one units of RCA's weather detection and penetration radar will be installed by Qantas aboard its American-made Super *G* Constellations. The home base of Qantas Empire Airways, Ltd., is Sydney, New South Wales. This radar system, known as *AVP-10*, provides pilots with early warning of approaching storm centers as far away as 150 miles, enabling the pilots to follow nonturbulent air paths through and around these storm centers. It is compact and light, weighing only 125 pounds. Similar RCA equipment has been fitted aboard 13 additional United States and foreign airlines, covering important domestic and world aviation routes. The Royal Australian Air Force also uses the equipment.

(Continued on page 38A)

Principles of Transmission Line Relaying

This booklet (S-81) has been compiled by the AIEE Committee on Relays Subcommittee on Line Relay Protection. The objective is to present basic relaying philosophy rather than details and characteristics of specific relaying systems. Thus, to one who is not a relay specialist, the booklet is an opportunity to become familiar with the principles involved. The relay engineer will find presented a broad cross section of line relaying fundamentals that will be useful in his work, and engineers undertaking relay work will find these papers to be a valuable introduction and reference source.

More advanced forms of transmission line relaying, such as microwave relaying that are just coming into being, are not included in these papers, nor are simple straightforward applications considered. A concerted effort has been made to direct attention to the fundamental concepts and practices used in providing modern transmission line relay protection.

This 64-page special publication is available for the price of $1.00. Write for copies to:

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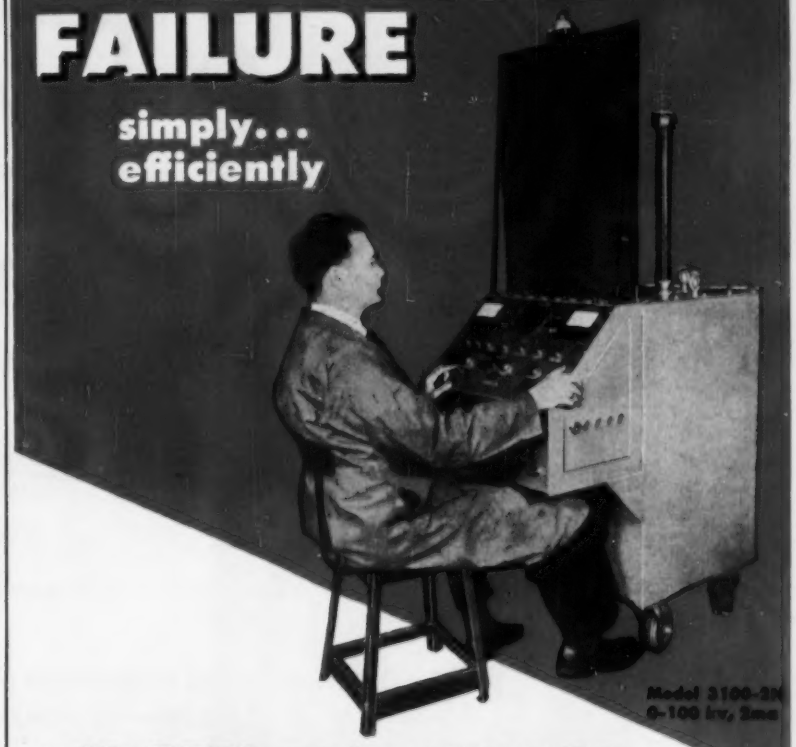

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- OUTPUT CURRENT — 1 to 5 ma, continuously available at rated output voltage
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- LINE VOLTAGE STABILIZATION — ±1% for ±15% variation from rating

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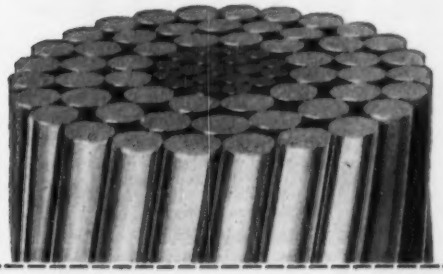

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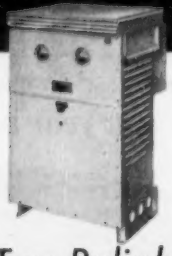

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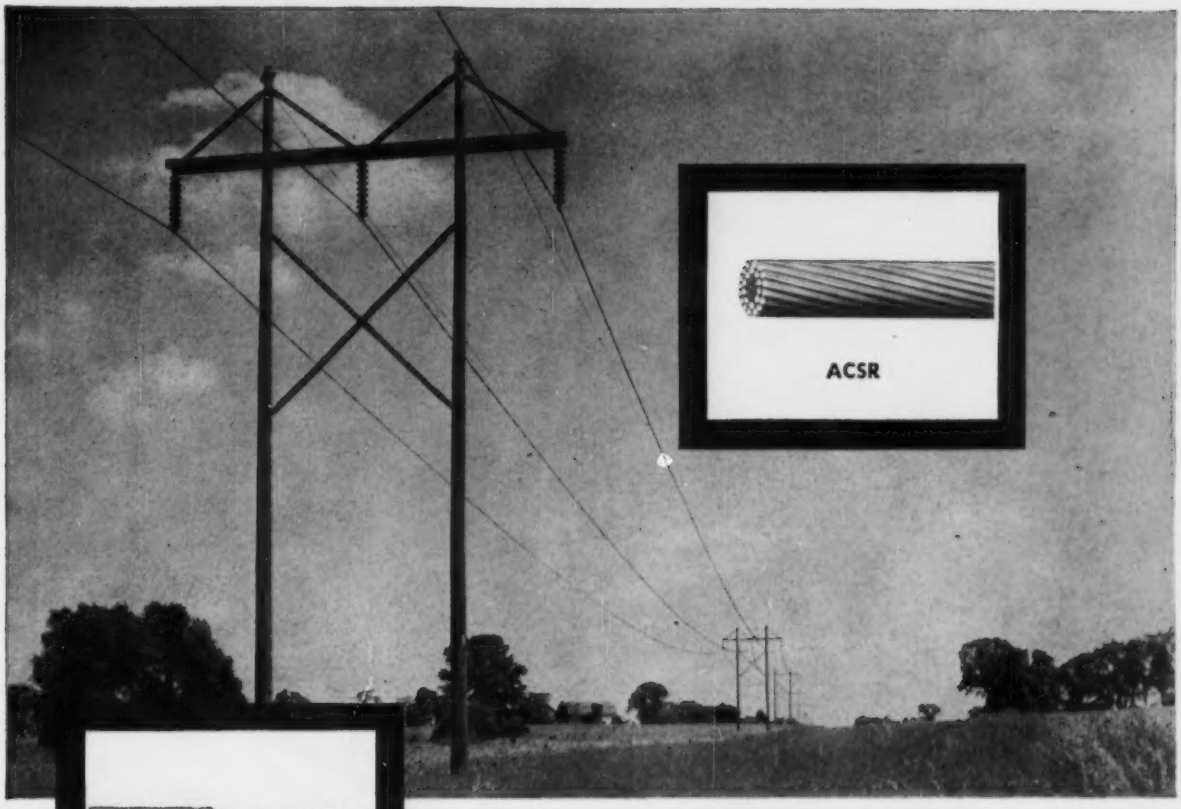

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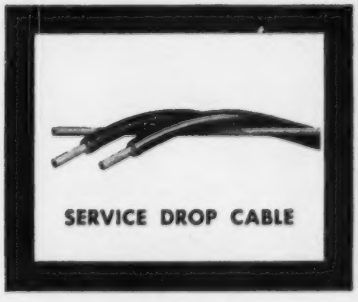
ALECTRAL ALUMINUM CONDUCTORS



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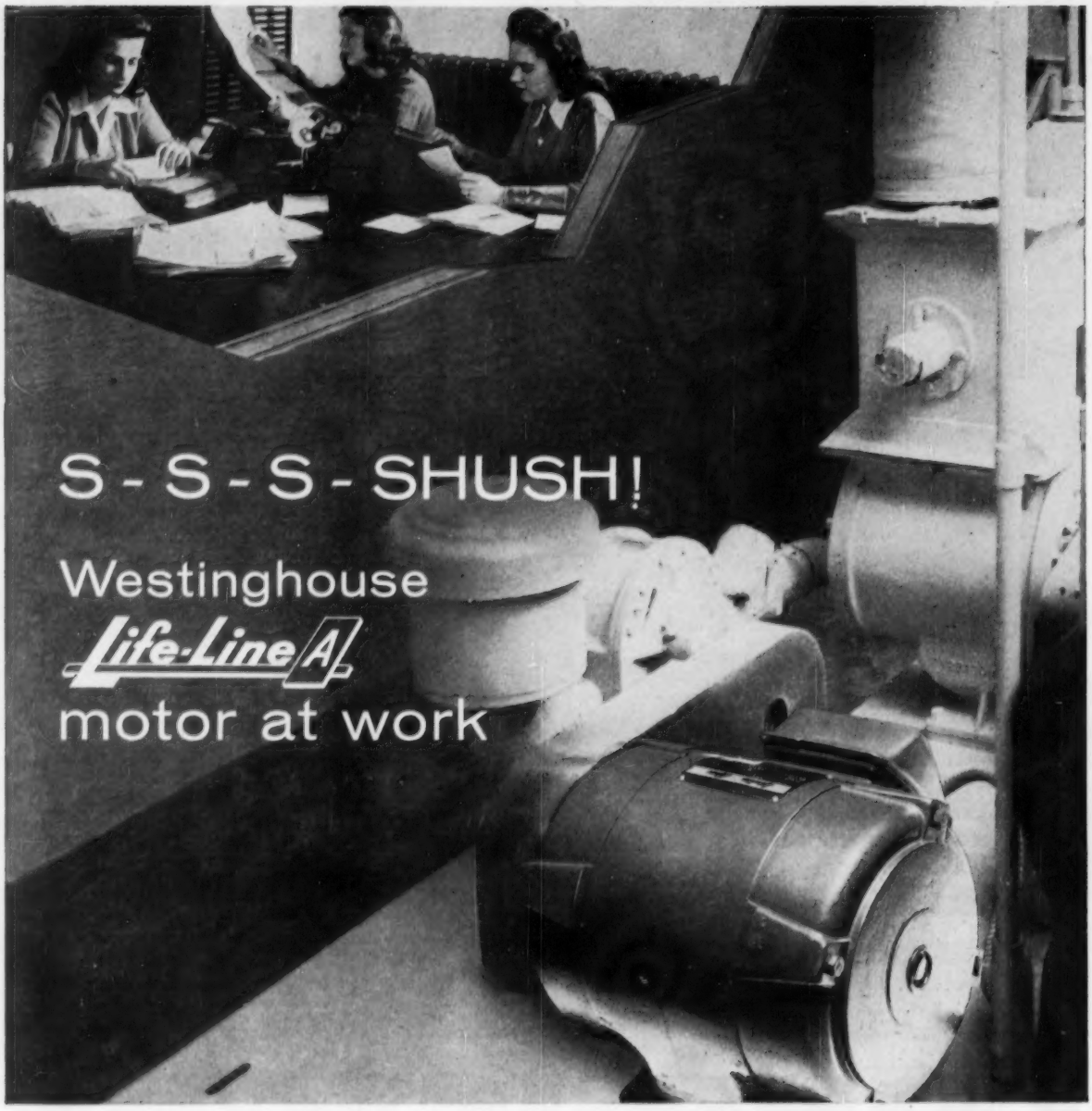

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For manufacturers of electrical equipment, for example, Tubemanship has produced Wolverine Trufin®—the integral finned tube that gives added capacity to transformer oil coolers. Or, if their specifications call for prime surface tube, manufacturers can select from a wide range of sizes and alloys in both aluminum and copper.

When components such as copper or aluminum connectors or tubular switch gear are needed, Wolverine's complete fabrication facilities can shape them to customer specifications. Included in Wolverine's two-plant facilities is equipment for finning, spinning, bending, coiling, flaring, expanding, beading, etc.

Next time your requirements call for copper or aluminum tubing or tubular-shaped parts, remember that there is a difference in tubing—**Tubemanship is that Difference.** For the complete story write—today—for your copy of Wolverine's new book "The Measure of Tubemanship"

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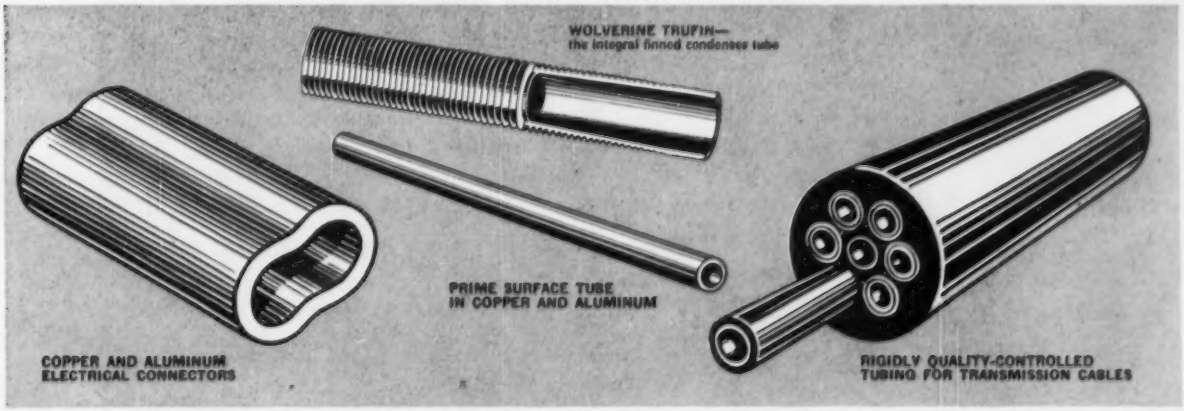

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no. 4 tap thru 2/0 splice

Now, you can install a wide range of distribution connectors on all conductors up to 2/0 . . . with just a single tool. The new MD-4, with interchangeable jaw inserts, will handle taps, splices, deadends for copper or aluminum through size 1/0 ACSR—or 2/0 for the Hysplices.

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Accessories include an insulating neoprene cover for the Hytool head, and a canvas carrying bag or steel case. Write Burndy for details.

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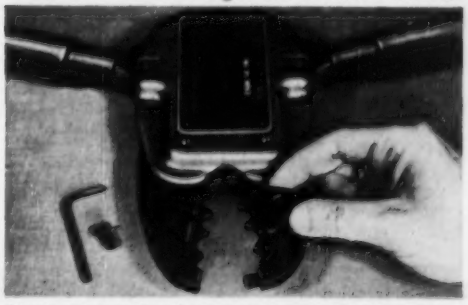

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HUGHES SILICON RECTIFIERS

Hughes introduces a new series of high-quality silicon rectifiers, especially designed for use in miniaturized circuitry. These new low-power rectifiers are characterized by low forward voltage drop, together with low back leakage. They are exceptionally efficient units in electronic power supplies and, in such applications, can be used in place of many conventional vacuum tubes.

The new Hughes Rectifiers feature: maximum AC input voltages up to 275 volts RMS; maximum reverse DC working voltages up to 375 volts; maximum average rectified forward current up to 200mA; maximum power dissipation (at 25°C) up to 200mW. Operating temperature range for all types: −75°C to +150°C.

PHYSICAL CHARACTERISTICS

All Hughes Rectifiers are packaged in a one-piece, fusion-sealed glass body. This famous construction is impervious to moisture penetration, ensures stable operation under severe operating conditions. Maximum dimensions, rectifier glass body: length, 0.265-inch; diameter, 0.105-inch.

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HUGHES
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FROM DATA TO DIGITS...

Today Hughes is developing systems which convert radar data and other information to digital form and process it for use in performing control functions.

These systems will be able to receive and store vast quantities of data from many different sources and distribute it, after processing, over large and complex ground nets.

Special-purpose digital computers are employed, utilizing magnetic drum memory and novel programming techniques. The systems will also include visual displays and employ the latest concepts of human engineering to simplify equipment operation and minimize the possibility of human error. Vacuum tubes are being replaced by transistors or ferrite cores in flip-flops, registers, and amplifiers; and diode matrices are being replaced by ferro-magnetic circuitry.

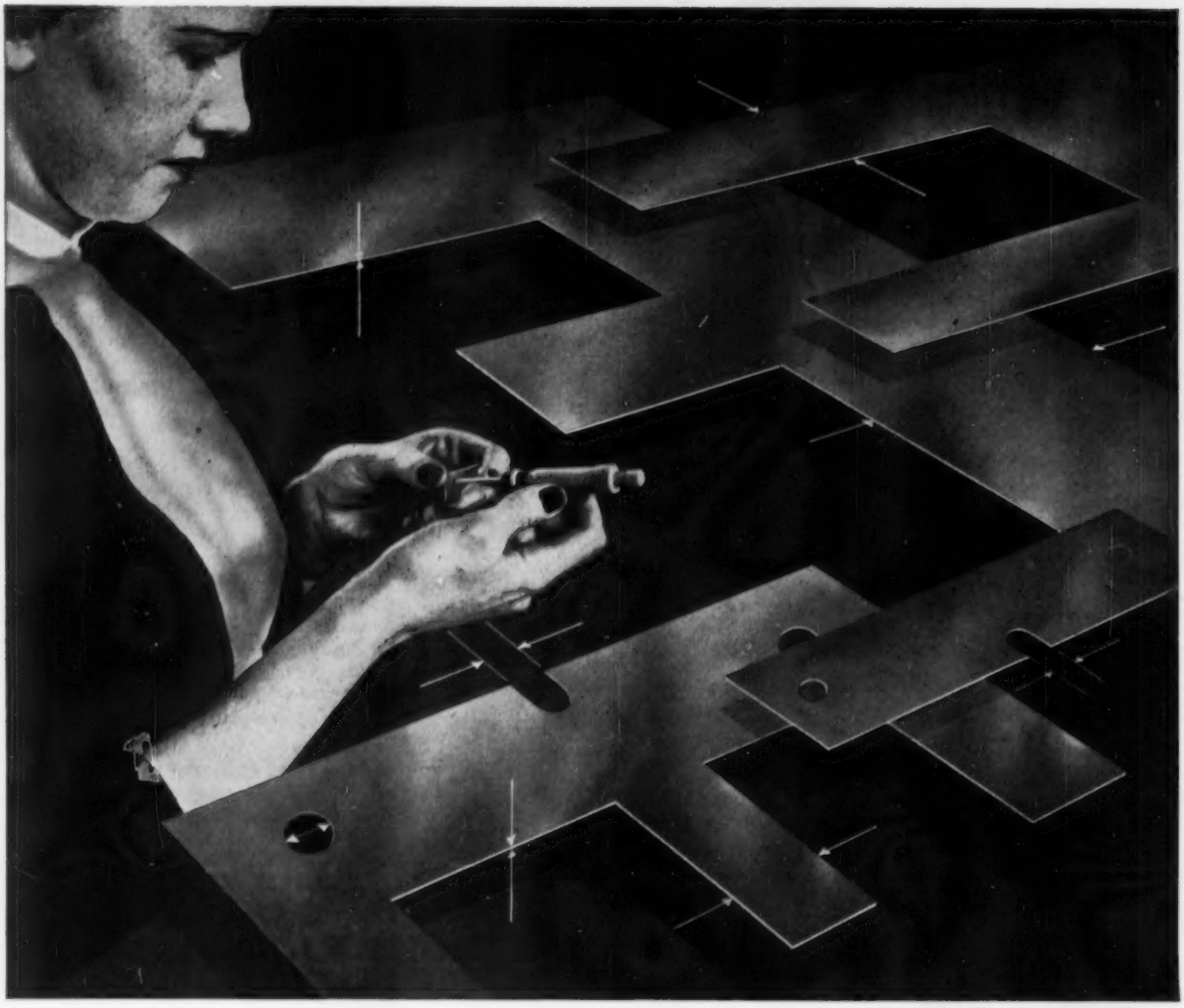
These and other features of the new systems promise to maintain and extend Hughes leadership in the fields of digital computers and processing systems. In order to design and build these and future systems, Hughes requires engineers with experience in electronic circuit design, logical design, electronic packaging, radar systems, and many others.

For further information write us at the address below.

HUGHES

RESEARCH AND DEVELOPMENT LABORATORIES
SCIENTIFIC STAFF RELATIONS
Hughes Aircraft Company, Culver City, Calif.

KEEP UP-TO-DATE ON MAGNETICS



what are the new Performance-Guaranteed laminations?

Whenever our tungsten-carbide dies have produced enough nickel-iron laminations of a new shape to permit stocking them for immediate delivery, we let you know, because we get so many requests for "what's new in *Performance-Guaranteed* laminations?"

It's rather sensible, the emphasis our customers put on this "Performance-Guarantee." They know it's a guarantee based upon our *higher* quality hydrogen annealing, vital for high permeability laminations.

You see, small percentages of impurities, particularly carbon, oxygen and sulphur, have a deleterious effect on magnetic properties—and they are present in every alloy at the beginning despite the most rigid control of the metallurgy of the heats. In this as-rolled state, *the steel will develop as little as 5% of its ultimate permeability.*

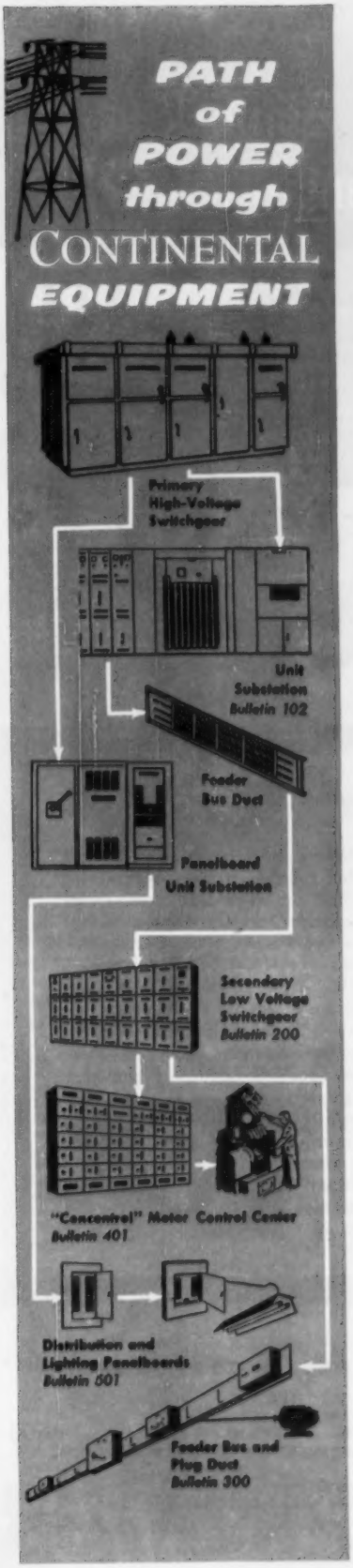
Now everyone "hydrogen" anneals—but not everyone *dry-hydrogen* anneals. You can't use bottled hydrogen, without leaving a surface oxide injurious to magnetic properties and making soldering virtually impossible. So we dry our hydrogen to a dewpoint of —60° C, removing the water vapor which is produced by the reduction of hydrogen. Carbon reduces to methane, sulphur to sulphur dioxide, and both are removed by the continuous flow of dry hydrogen during the 24-hour cycle.

As a result of our superior annealing, *we* develop better magnetic properties and clean lamination surfaces, and *you* get that valued "Performance-Guarantee."

New Performance-Guaranteed shapes, in stock, immediately available: EE 28-29, UI-312, F-21, DU-1, DU-37, rotor, stator and head laminations. Why not write today for Catalog ML-201 and full information on these and all other clean, flat, burr-free laminations we manufacture. *Magnetics, Inc., Dept. EN33, Butler, Pennsylvania.*

MAGNETICS inc.

CABLE: MAGNETICS


PATH of POWER through
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Unit Substation Bulletin 102
Feeder Bus Duct
Panelboard Unit Substation
Secondary Low Voltage Switchgear Bulletin 200
"Concentrol" Motor Control Center Bulletin 401
Distribution and Lighting Panelboards Bulletin 501
Feeder Bus and Plug Duct Bulletin 300

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MOTOR CONTROL CENTERS

"Concentrol", achievement of CONTINENTAL design, engineering and craftsmanship, assures you of maximum personnel safety and production continuity in a motor control center. Self-supporting, pre-wired and standardized, it cuts installation time and costs, saves hours of engineering.

- ***MODULAR CONSTRUCTION*** — structures can be added or moved quickly, easily.
- ***SPACE SAVING*** — back-to-back arrangement requires half the floor space.
- ***EASY ACCESSIBILITY*** to all units, for reduced maintenance.
- ***ALUMINUM*** construction available.
- ***USES STANDARD STARTERS*** of your own choice.

Compare for yourself.
Write for Bulletin 401 today.

SHIPMENT: 4 Weeks*

NEW "Concentrol" PLUG-IN UNITS

. . . for greater safety, easier insertion and removal. All wiring is accessible from front. Removable door hinges facilitate installation and maintenance.

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General Offices: 203 West 4th Street, Cincinnati 2, Ohio

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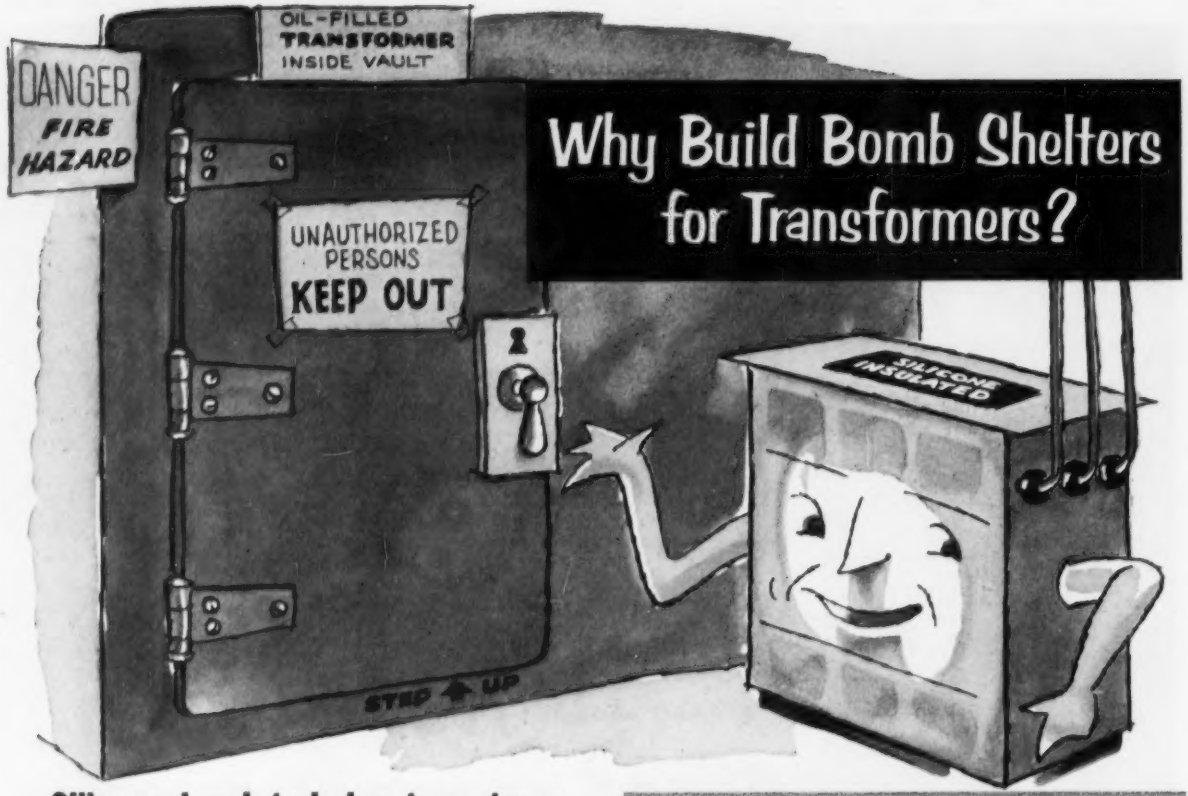
*Standard arrangements with size 1, 2 and 3 full voltage, non-reversing starters. For other arrangements or starter requirements, refer to Factory.



Why Build Bomb Shelters for Transformers?

Silicone insulated dry-type transformers need no vaults, are safer, more reliable and less expensive.

SAFER . . . no explosion, fire or toxic hazards with silicone insulation.

MORE RELIABLE . . . silicone insulation is inherently more resistant to high ambients, heavy overloads, moisture and corrosive atmospheres.

LESS COSTLY . . . silicone insulation can harness more power per pound. That means smaller transformers that can be installed close to load anywhere in your plant saving space, copper and installation costs.

. . . your power distribution system is more efficient, more flexible and adaptable with silicone insulated dry-type transformers.

. . . silicone insulated dry-type transformers require no expensive vaults or special ventilating systems.

. . . your maintenance costs drop to almost nothing with silicone insulated dry-type transformers. All that's required is an occasional dusting — no liquids to replace or filter.

Mail coupon today for additional information.

Dow Corning Corporation, Dept. 4115, Midland, Mich.

Please send me sources of supply for new Silicone (Class H) ☐ Motors ☐ Transformers

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DOW CORNING SILICONES

pt your proof of reliability

Where is there a more vital need for reliable transformer service than in a major commercial airport? The greater Fort Worth International Air Port uses two Pennsylvania Transformer Company units, both 1000 KVA, three phase, 60 cycles, 150 C rise. Insulated with Dow Corning Silicones, these dry-type transformers carry all power for Fort Worth's field and terminal lighting system. Silicone insulation was specified because it provides a greater guarantee to public safety; is more dependable, and has the overload capacity to handle emergency loads.

DOW CORNING CORPORATION
MIDLAND, MICHIGAN

ATLANTA • BOSTON • CHICAGO • CLEVELAND • DALLAS
DETROIT • LOS ANGELES • NEW YORK • WASHINGTON, D. C.

CANADA: Dow Corning Silicones Ltd., Toronto
GREAT BRITAIN: Midland Silicones Ltd., London
FRANCE: St. Gobain, Paris

Compact amplifier-voltmeter with millivolt sensitivity

High frequency extended range oscillator

Low-distortion, wide-band bridge type signal generator

BIG PERFORMANCE IN SMALL PACKAGES

Type 346 double-duty meter instrument. Serves simultaneously as vacuum tube voltmeter and highly sensitive a-c voltage amplifier.

METER RANGES: 0.001, 0.003, 0.01, 0.03, 0.1, 0.3, 1.0, 3.0, 10.0, 30.0, 100.0, and 300.0 volts full scale. **ACCURACY:** ±3%, 20 cps to 1 mc, ±5%, 10 cps to 2 mc. **STABILITY:** ±1% at any line voltage between 105 and 130 volts ac. **INPUT IMPEDANCE:** 10 megohms – shunted by 24 uuf. **AMPLIFIER:** Maximum voltage gain 1000; maximum output voltage 1 volt. **OUTPUT IMPEDANCE:** 600 ohms resistive. **HUM AND NOISE:** One minor division max. **OVERLOAD:** Automatic overload protection. **POWER REQUIREMENTS:** 117 volts ±10%, 50-400 cps 40 watts. **SCALE:** Illuminated 4¼" damped meter movement. **DIMENSIONS:** 6½" high, 4¼" wide; and 7½" deep overall. Weight: 6½ lbs.

PRICE **$200***

Type 347 extended range oscillator featuring extended high frequency range, low waveform distortion, constant level output and remarkably small physical size.

FREQUENCY RANGE: 18 cycles to 1.1 mc in five overlapping ranges. **DISTORTION:** Total harmonic distortion of waveform less than 2/10 percent when operated into 10K ohms or higher load. **CONSTANT OUTPUT:** Output voltage constant to within ±½ db from 18 cps to 200 kc for any output over 0.1 volt. High range ±2 db. **OUTPUT LEVEL:** 10 volts open circuit. Maximum load current: 4 ma. rms. **OUTPUT CONTROL:** Logarithmic control calibrated in volts. **INTERNAL IMPEDANCE:** Approximately 400 ohms. **CALIBRATION ACCURACY:** ±2% (+1 cycle) from 18 cps to 210 kc, +10% to 1.1 mc. **STABILITY:** ± 0.3% for line voltage range of 105 to 130 volts, and ±0.5% for temperature range of 0 to 50°C. **HUM AND NOISE LEVEL:** 3.0 Millivolts or 60 db below output signals, whichever is greater. **DIMENSIONS:** 6½" high, 4½" wide, 6" deep overall. Weight: 6 lbs.

PRICE **$150***

Type 348 signal generator provides low distortion sinewave signals between the frequencies of 0.9 cps and 510 kc. Just right for design investigations of magnetic amplifiers, servomechanisms, computers and general laboratory and field use.

FREQUENCY CHARACTERISTICS

RANGES: 0.9 cps to 510 kc in six ranges. **STABILITY:** ±0.5% for frequencies up to 100 kc for line-voltage variations 105 to 130 volts and temperature within 0 to 50°C. **CALIBRATION ACCURACY:** ±2% (+½ cycle) above 10 cps; ±5% below 10 cps. **DISTORTION:** Less than 0.1% over most of the useable range rising to less than 0.3% at 30 cps.

AMPLITUDE CHARACTERISTICS

OUTPUT LEVEL: 50 volts, ±10% 2 watts or 40 ma maximum. **OUTPUT RANGES:** Continuously variable from 0 to 0.05V; 0.5 volts; 5.0 volts; 50.0 volts. **STABILITY:** ±0.5 db referred to 1 kc over the entire frequency range. **OUTPUT IMPEDANCE:** At the 50 volt output range – 6 ohms in series with 1000 microfarad; 5 volt output range–6 ohms in series with 1000 uf; 0.5 volt range–55 ohms; 0.05 volt range–6.2 ohms. **POWER SUPPLY REQUIREMENTS:** 117 volts ac, ±10%; 50-400 cps, 110 watts. Fuse protection; 1.6 amperes, slow-blow. **DIMENSIONS:** 9-7/8" high, 7-5/16" wide, 10-11/16" deep overall. Weight: 19 lbs.

PRICE **$325***

** Price slightly higher in 50 cycle areas.*

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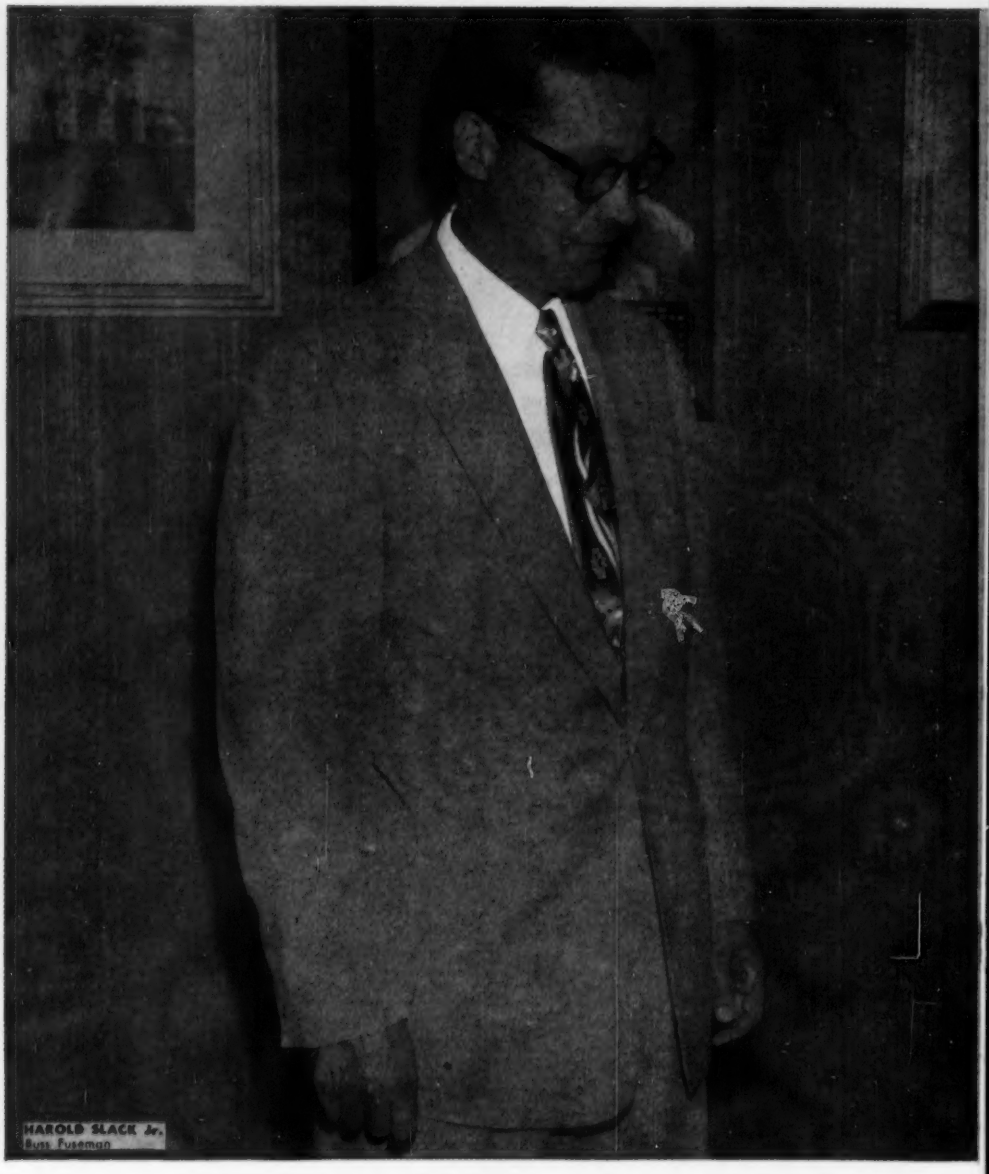
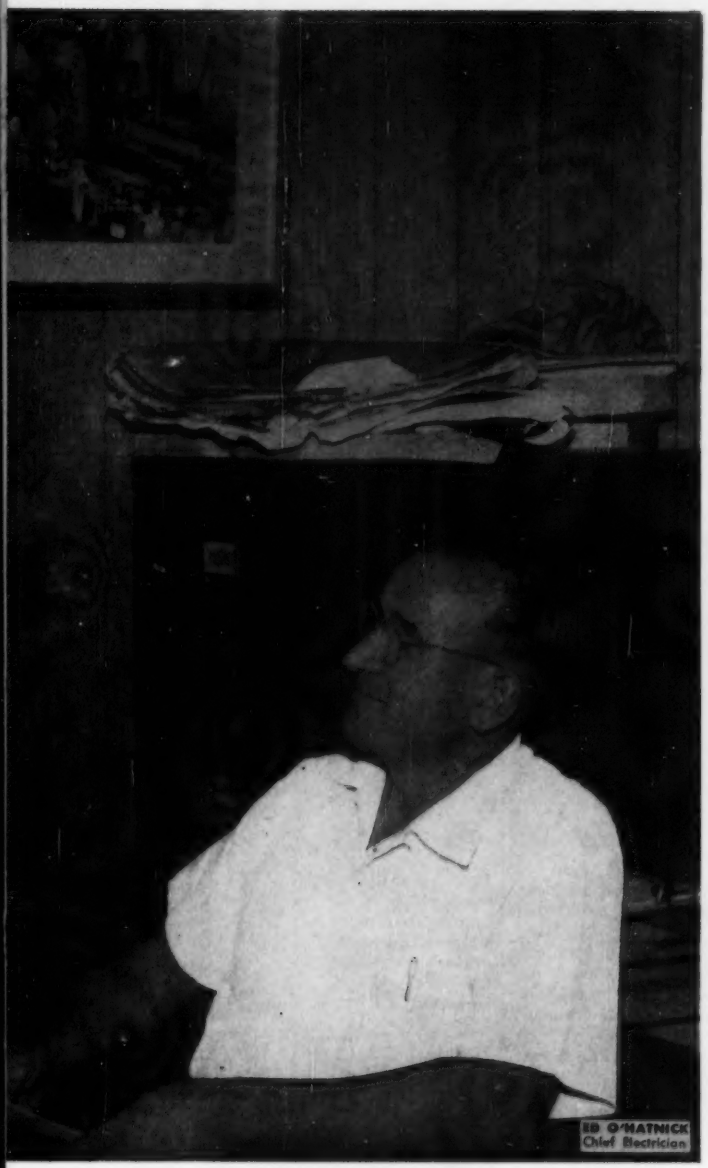


"By installing Fusetron Fuses . . .

We saved from $165 to $225 worth of solenoid coils a year and reduced down-periods"

ED. O'HATNICK, CHIEF ELECTRICIAN
FRANK KNEELAND PLANT, UNITED ENGINEERING & FOUNDRY CO.
PITTSBURGH, PA.



Mr. O'Hatnick continues . . . "The solenoids on the hydraulic clutches of our horizontal boring mills would sometimes stick or slow down when dirt got into the oil.

"When this happened, the tap D. C. solenoid coils wouldn't be pulled in far enough so they would burn up.

"Each coil cost about $15 and with 12 to 18 of them burning up every year it didn't take long for this to add to a considerable amount of money.

"And even more costly were the production losses that resulted from these shutdowns.

"With hope of reducing these expenses, we decided to individually protect the 72 solenoids in use with 3/10 ampere Fusetron dual-element fuses.

"In the next 3 years only 2 coils burned up.

"We had other favorable experiences with Fusetron fuses that convinced me they can make a plant more effective.

"That's why, upon being transferred to our Frank Kneeland Plant, I made a study to see where Fusetron fuses can be applied to help us reduce operating costs."

Here's why Fusetron dual-element Fuses protect solenoids, coils and transformers against burnout.

By installing the proper size Fusetron dual-element fuse, a solenoid can be protected. The Fusetron fuse will not open on the operating surge but will open in time to protect, should the heavy current continue too long for any reason.

A transformer or coil, likewise, can be protected because the long time-lag of the Fusetron fuse permits it to hold all normal current surges and harmless overloads—yet it will open to prevent burnout on any dangerous overload.

All you need to protect Coils, Transformers or Solenoids against burnout is a Fusetron fuse plus a fuse block or a BUSS fuse holder.

On voltages up to 125 the same dependable protection can be provided with a proper size Fusetron plug fuse or BUSS Fustat.

FUSETRON FUSES DO MORE THAN PROTECT SOLENOIDS AGAINST BURNOUT . . . ***They Provide 10 Point Protection*** **1.** High interrupting capacity—protect against heaviest short circuits. Have proven on tests to open safely on circuits set to deliver in excess of 100,000 amperes. **2.** Protect against needless blows caused by excessive heating — lesser resistance results in cooler operation. **3.** Protect against needless blows caused by harmless overloads. **4.** Provide thermal protection — for panels and switches against damage from heating due to poor contact. **5.** Protect against waste of space and money — permit use of proper size switches and panels. **6.** Protect motors against burnout from overloads. **7.** Give DOUBLE burnout protection to large motors — without extra cost. **8.** Protect motors against burnout due to single phasing. **9.** Make protection of small motors simple and inexpensive. **10.** Protect coils, transformers and solenoids against burnout.

Write for bulletin FIS.

FOR LOADS ABOVE 600 AND UP TO 5,000 AMPS . . . USE BUSS HI-CAP FUSES! When coordinated with Fusetron fuses they will not open ahead of the fuse nearest fault.

Write for bulletin HCS.

Play Safe! *install FUSETRON dual-element Fuses and BUSS Hi-Cap Fuses throughout entire Electrical System!*

FUSETRON
TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION
BUSS

BUSSMANN MFG. CO. *Div. of McGraw-Edison Co.*
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ARE YOU LOOKING FOR DIVERSITY?

You can work in these fields at Bendix in Southern California

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Bendix-Pacific offers you this broad cross section of absorbing tasks.

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I am a graduate engineer with ____ degree.
I am not a graduate engineer but have ____ years experience.

Name _____

Address _____

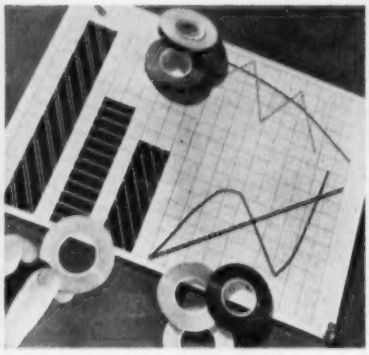
City _____

Zone ____ State _____

(Continued from page 20A)

NEW PRODUCTS

Tape for Charts. A method of graph and chart-making, resulting in neater, more attractive, and easier-to-reproduce layouts, has been announced by American Chart Service, Inc., (ACS), 101-103 Dover St., Somerville 44, Mass. The method is based on a series of self-adhesive acetate fiber tapes in various widths, colors, and designs. The tapes are rapidly applied to almost any surface and the narrower widths can be curved with ease. Once made, graphs can be changed easily by peeling the tape off and replacing with new tape. Long-lasting adhesive backing assures permanency of the charts made. Tapes come in 15 different colors, 6 widths, and 9 different striped designs.



This enables artists to present clearly the most complex graphs and charts having a multitude of values and variables. Tape widths range from 1/32 inch to 1 inch. To be able to slit tape to such narrow widths, ACS specified Aeroflex core tubing made by Anchor Plastics Company, 36-36 36th St., Long Island City 6, N. Y. Aeroflex has a smooth waxy finish and does not delaminate or split. Unlike tape wound on other materials, where the last turn is wasted, every inch of tape on an Aeroflex core can be used, eliminating all waste.

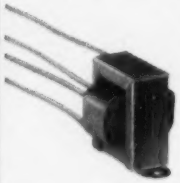
Flame-Resistant Glass Cloth. An epoxy resin pre-impregnated glass cloth manufactured by Standard Insulation Company, East Rutherford, N. J., is being used in laminates exhibiting such outstanding electrical characteristics as 83 million megohm cm volume resistivity, 25 million megohms surface resistance, and 18 million megohms insulation resistance. This material has been engineered primarily for critical electrical and electronic laminates as in printed circuits. Stanpreg epoxy glass is furnished in dry, nontacky, easily handled rolls adaptable to all necessary operations. Uniform resin content, consistent optimum flow characteristics, and extended shelf life are insured by carefully controlled impregnating procedures. Stanpreg is supplied in tapes or full width rolls. Technical data, suggested curing cycles, and samples are available.

(Continued on page 50A)

WHEREVER *Quality* COUNTS

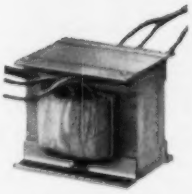
you're wise to specify HEVI-DUTY transformers

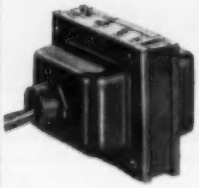
You can be sure of dependable operation of electrical components when you use Hevi-Duty transformers.



Coils are precision-wound with high-dielectric insulating materials between layers.

Every Hevi-Duty transformer is impregnated with a polymerizing-type varnish that resists moisture and corrosion.





All Hevi-Duty units are built and tested to meet or exceed NEMA, ASA and AIEE standards. Terminals or poly-vinyl-insulated, color-coded leads are firmly anchored to coils.

Whether your plans call for 1 transformer or 1,000, Hevi-Duty offers complete facilities to assist in designing and building a transformer to meet your precise requirements. Send us your specifications, or write for

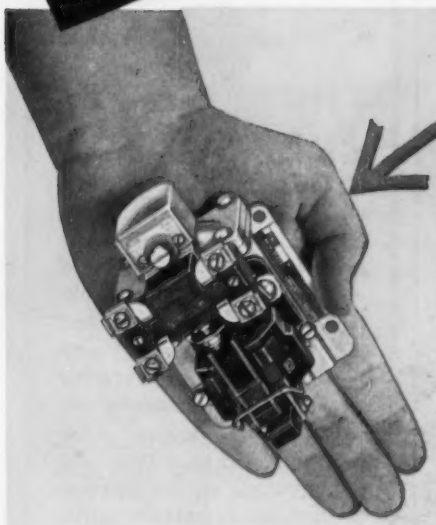
BULLETIN HD-499.

HEVI-DUTY®

HEVI-DUTY ELECTRIC COMPANY
MILWAUKEE 1, WISCONSIN

Heat Treating Furnaces . . . Electric Exclusively
Dry Type Transformers Constant Current Regulators

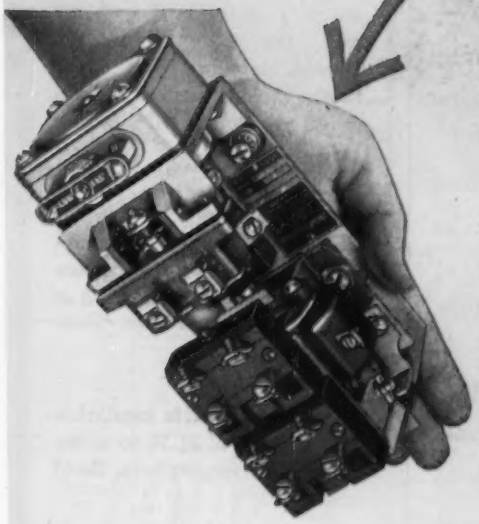
What's Your Timing Problem?—ONE OF THESE TIMERS WILL DO YOUR JOB *Exactly!*



NEW...Type A

REALLY SMALL IN SIZE AND COST!

for applications requiring shorter timing periods, ±15% accuracy and no interlocks



Type B

MACHINE TOOL STANDARD FOR MORE THAN 20 YEARS!

for applications requiring timing periods up to 3 minutes, maximum accuracy and 1 or 2 instantaneous interlocks

COMPARISON	TYPE A	TYPE B
Timing Period	.2 to 1 min.	.2 to 3 min.
Accuracy	±15%	±10%
Interlocks	None	Max. 2 Double Circuit
Panel Space	2⅜" x 4"	2½" x 7⅜"
Convertible Delay-On • Delay-Off	Yes	Yes
Maximum Voltage AC—DC	600 V. AC only	600 V. AC 250 V. DC

Write for Timer Bulletin 9050
Address Square D Company, 4041 North Richards Street, Milwaukee 12, Wisconsin

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slips through the seas . . .
the scientific community continues to expand . . .
and, planning for the future,

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in all areas of pure and applied science.

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THERMAL EVALUATION OF INSULATING MATERIALS

(June 1954)

At the 1954 Winter General Meeting the Subcommittee on Dielectrics and its Working Group sponsored three sessions of papers covering various phases of the problem of evaluating insulating materials. Since these papers review much of the recently developed information on this subject, it was decided to reprint them in this form. As test methods on the thermal evaluation of insulating materials become available, more and more data on thermal stability of both the newer and the older materials should develop, and eventually make possible the rational revision of AIEE Standard Number 1 on a sound basis.

The 72-page printed publication contains 16 papers and discussions, presented at the 1954 AIEE Winter General Meeting.

Publication S-61 is available at the price of $1.50 to members and nonmembers. Send orders to:

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AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

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Now...an accomplishment so far reaching it will change the sights of all rectifier users

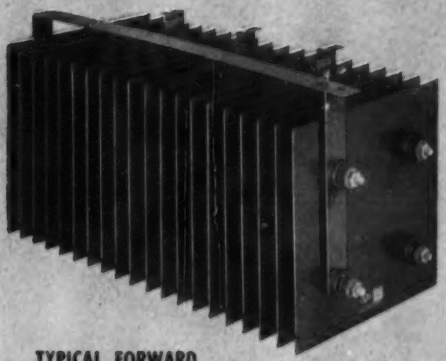
RADIO RECEPTOR'S improved new vacuum process

HCD* PETTI-SEL

**High Current Density*

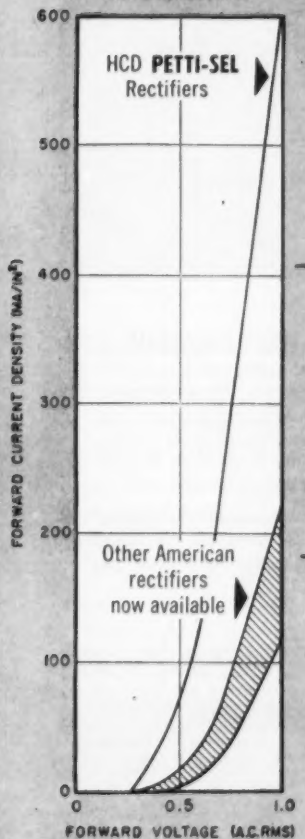
Industrial type SELENIUM RECTIFIERS

Developed by the famous Siemens Organization of West Germany and now manufactured by Radio Receptor Co. in the U. S. A.



- **Estimated life 100,000 hours**
- **Much smaller cell sizes than conventional units of the same ratings**
- **Lower forward voltage drop**
- **Suitable for high temperature applications**

TYPICAL FORWARD CHARACTERISTICS

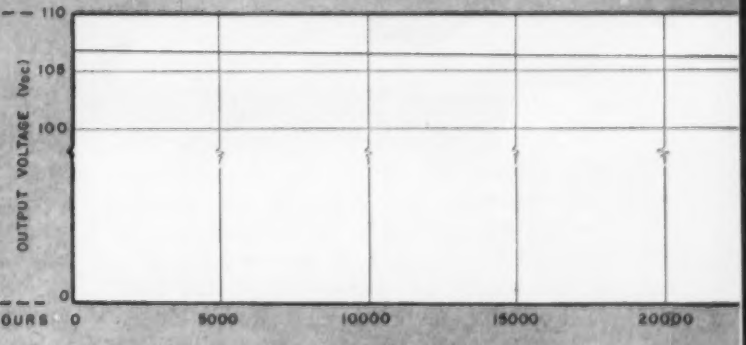


Far smaller in size than other rectifiers of the same current ratings, the new Radio Receptor HCD Petti-Sel units are manufactured under laboratory controlled conditions with fully automatic machinery, assuring new standards of product uniformity.

Field experience extending over several years with these rectifiers indicates an estimated life of 100,000 hours. This is largely attributable to the special process requiring no artificial barrier layer. Low forward voltage drop and low aging rate make the new Petti-Sel Rectifiers applicable to magnetic amplifiers and other control applications.

TYPICAL AGING CHARACTERISTIC

Cell size 4" x 4", single phase bridge (4-5-1-B) operated at 130 volts AC input, 8 amperes DC output current, resistive load, 35° C ambient temperature.



Watch for further announcements of unique developments on these history-making rectifiers. If you would like our new bulletin as soon as it is available, write today to Section EL-3.

Semiconductor Division

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Clear, sharp, accurate traces
Pushbutton chart speeds (1/16 to 160 in/sec) while operating
Automatic selection time-line interval
Record numbering for identification
Automatic control of trace density
Burned-out lamps replaced automatically

You've asked for the dependable features of this AUTOMATIC OSCILLOGRAPH

The S-25 can be your answer to modern research demands for a reliable oscillograph, never failing to record the specific information so vital to the success of costly research, design and development work. The exclusive features shown on the record, and remote control, make the S-25 your choice, whether it is to be used in small laboratory research or industrial development work.

Eliminate costly recording failures by using the reliable S-25 Automatic Oscillograph, now available for rapid delivery. Investigate the many exclusive features of the S-25 by writing for Bulletin 1-2C.

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New Hubbard Film Demonstrates Lightning Arrester Operation

The subject of power system lightning protection is complex and difficult to explain by conventional methods. This film, using new techniques of animation and ultra-high speed photography, facilitates the understanding of the many variables entering into the problem of lightning protection.

Produced in the Hubbard Research Laboratories especially for utility personnel, this film entitled "The Magic Cylinder" details formation of natural lightning, the effects of lightning on a power system, the duty on arresters, and the operational characteristics of the types in current use.

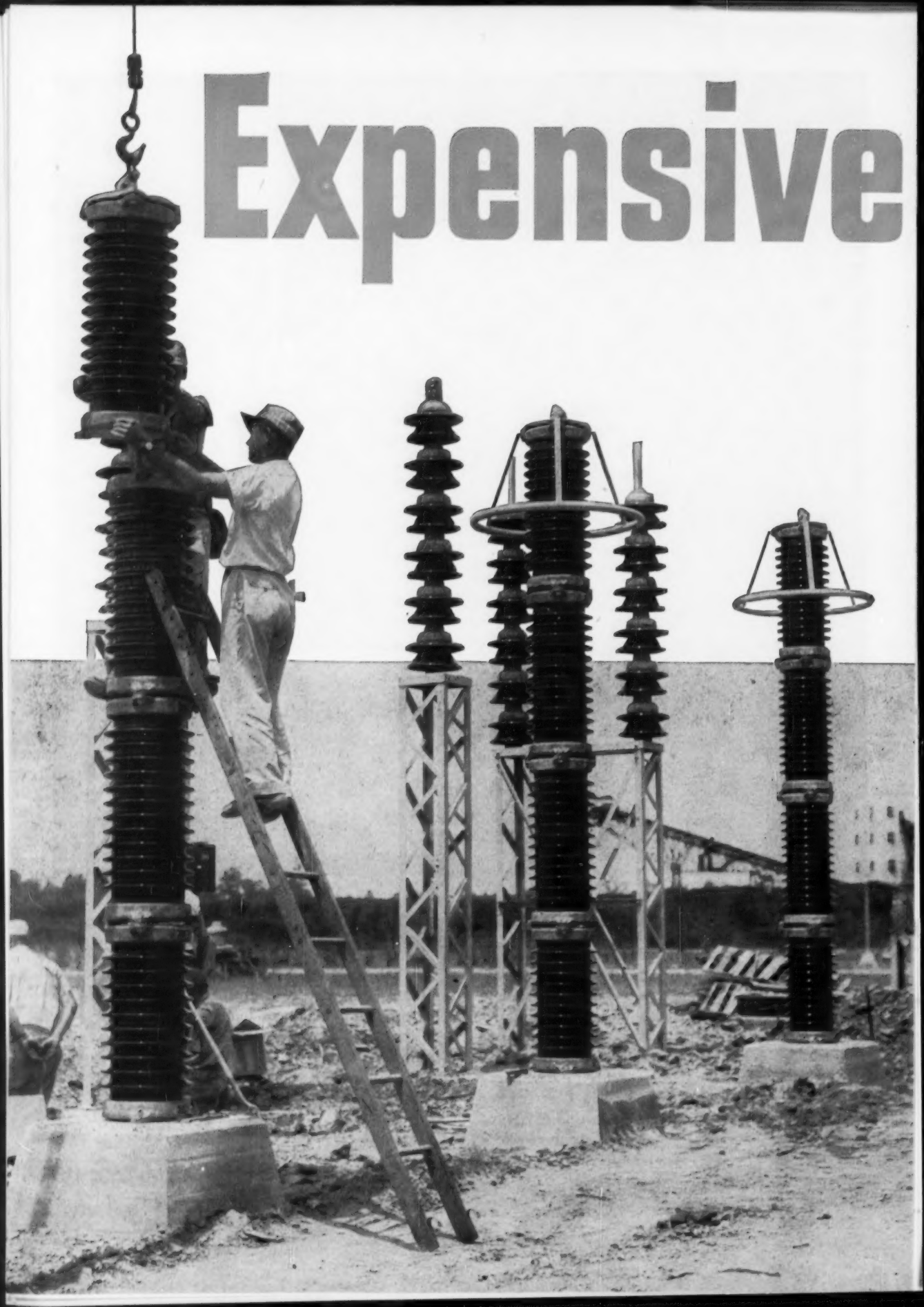
In full color and sound, with running time of 28 minutes, the picture is without counterpart in its educational coverage of this complex subject.

You can arrange for a showing of this brand new color film by contacting the Advertising Department of Hubbard and Company, 6301 Butler Street, Pittsburgh 1, Pennsylvania.

HUBBARD AND COMPANY

Pittsburgh 1, Pa. • Chicago, Ill. • Oakland, Calif. • Plano (Dallas), Texas

Expensive



extras *disappear*

When You Protect Stations with Thorex Lightning Arresters

Typical of the money you can save with Thorex lightning arresters are these two recent cases.

A Southern property built a complete three-pole, 230-kv arrester with two ground men and a hoist operator in a total elapsed time of 1 hour and 28 minutes.

An Eastern property built a similar 230-kv Thorex arrester in only seven minutes per pole, again using only three men. Moving equipment between poles took additional time, but the job was cleaned-up in less than an hour.

Absolutely no external auxiliary supports were required for these 230-kv arresters. All the high costs of bracing were eliminated.

One arrester, complete, took 4¼ man-hours. The other took 3 man-hours. *And that was all!*

When do you consider an arrester is paid for? After you've paid the manufacturer's invoice? Far from it -- sometimes. You may not have gone more than half way. But when that arrester is a Thorex, expensive extras disappear.

Granted, no arrester is a bargain if it lacks protection. But the Thorex meets all published standards, comfortably. On top of this it has added protective features found nowhere else. It's really worth a premium, while it actually costs you less.

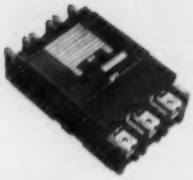
Is Thorex in your future planning? If not, a few minutes spent investigating it will be mighty profitable.

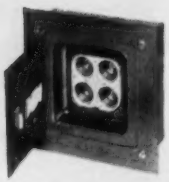
OHIO BRASS COMPANY, MANSFIELD, OHIO

Ohio Brass

4773-Ha

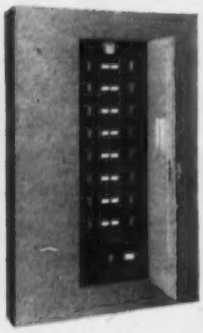
• Safety Switches and Industrial Circuit Breakers



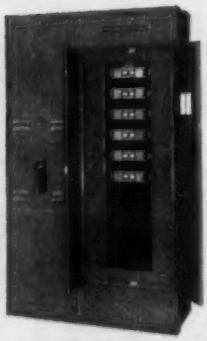


• Fusible and Circuit Breaker Load Centers

• Voltage Testers

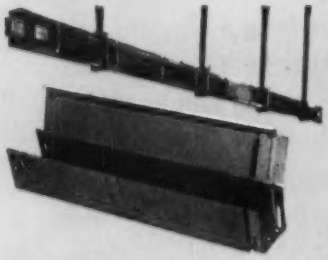


• Fusible and Circuit Breaker Lighting and Power Panelboards

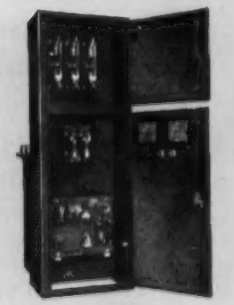


• Power Distribution Switchboards and Switchgear

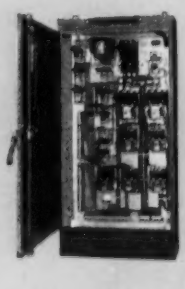
Wherever Electricity



• Busways and Wireways



EC&M High Voltage and Synchronous Starters

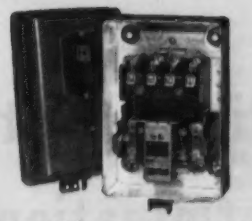


• Special Purpose Control

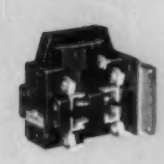
• Control Centers

SQUARE D COMPANY

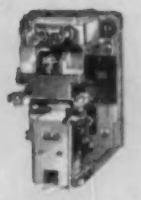
• A.C. Manual and Magnetic Starters



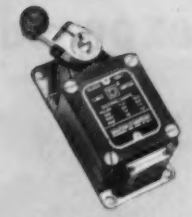
• Drum Switches



• Control Relays

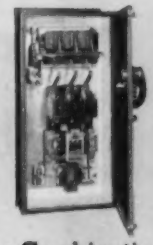


• Timing Relays



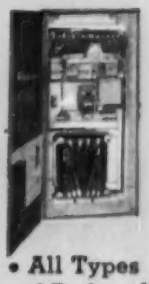
• Limit Switches

• Pushbuttons

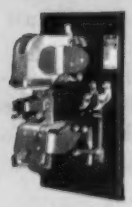


• Combination Starters

• Manual Compensators

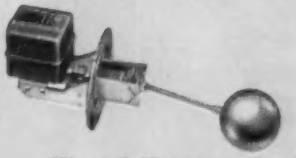


• All Types of Reduced Voltage Starters



• D.C. Starters

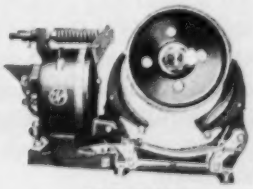
• Electronic and Electro-Magnetic Welder Control



• Float & Pressure Controls for Pumps & Compressors

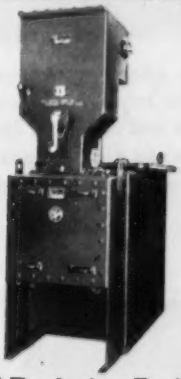
is Distributed and Controlled

EC&M
Lifting Magnets

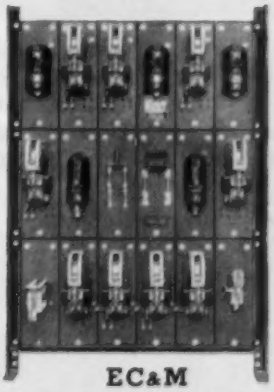


EC&M
Magnetic Brakes

FIELD ENGINEERING SERVICE
available through Square D branch offices
in all principal United States cities
... and in Canada, Mexico and England

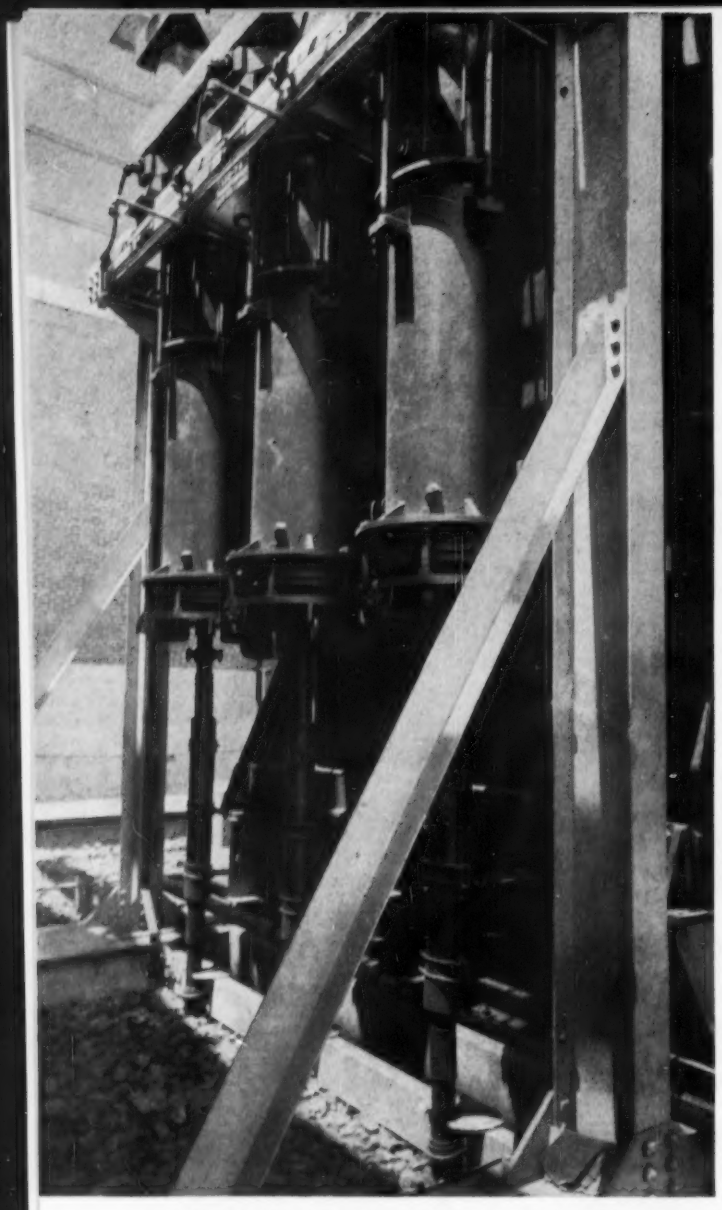


EC&M Explosion-Resisting
Control for
Petroleum Industry



EC&M
Crane and Mill Control

DESIGN LEADERSHIP FOR MORE THAN 50 YEARS



This 132kv Oilostatic system three phase termination direct to the high voltage side of the transformer eliminates exposed bus structures, bushings and potheads. The self-contained termination saves space and provides maximum safety because all "live" parts are enclosed.

Section of a typical Oilostatic system

Oilostatic transformer termination eliminates exposed bus structures

Advantages of a self-contained metal-clad transformer termination are evident from the photo at left. This neat, compact termination, being completely enclosed, insures maximum safety by eliminating exposed bus structures, bushings and potheads. Since 1949 this type of Oilostatic termination has been operating satisfactorily.

The installation shown is the termination of a 132kv Oilostatic system recently purchased by Public Service Electric and Gas Company of New Jersey. This system, *developed originally by Okonite*, consists of paper-insulated cables installed in a welded steel pipe filled with oil maintained at 200 psi.

Proof that Public Service Electric and Gas Company of New Jersey can expect to get outstanding performance from this installation is their previous experience with Oilostatic systems that date back to 1940. In addition, Oilostatic systems have been in successful operation elsewhere since 1932 and have recently been installed for operation at 230kv.

For information on Oilostatic systems, write for Bulletin EG-1044. Address: The Okonite Company, Passaic, N. J.

3755-A

Available with either copper or aluminum conductors

where there's electrical power . . . there's **OKONITE CABLE**

nuclear weapons development

SANDIA CORPORATION OFFERS OPPORTUNITIES FOR . . . *ENGINEERS, PHYSICISTS AND MATHEMATICIANS* IN THESE FIELDS

RESEARCH:
Studies of the reliability of systems components, nuclear weapons effects, aerodynamic characteristics, and quality expectation.

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Modern equipment in air conditioned laboratories, shops, and offices combines with liberal benefits, including free life insurance, sickness benefits, retirement and health protection plans, and extremely generous vacations and holidays to make Sandia an especially attractive place to work.

Albuquerque, with its exceptional climate and metropolitan blending of ancient and modern cultures, provides an informal, pressure-free environment for pleasant living. The city has an excellent school system. The University of New Mexico is also located here, providing opportunities for advanced study. Housing is readily available, and recreational facilities abound.

There are also openings for engineers and scientists in our expanding branch laboratory at Livermore, in the San Francisco area.

IF YOU'D LIKE MORE FACTS about Sandia Corporation, our background, our work, and the opportunities we offer, we'll be happy to send you our illustrated brochure which gives more details. Just write to Staff Employment Division 551A.

SANDIA CORPORATION

ALBUQUERQUE, NEW MEXICO

NOW! A NEW PEAK IN

Magnetic Permanency!

It's next to impossible to demagnetize Stackpole Ceramagnet® (ceramic) permanent magnets under any condition of use! Magnetism is permanently retained even in the presence of strong opposing fields or when the magnets are used without "keepers" or other short-circuit conditions.

Ceramagnet magnet energy product is adequate for practically any need. Non-critical ceramic materials are used exclusively. Electrical resistance approaches infinity. Eddy losses are practically nil. Permeability of approximately 1.0 is about that of air.

In most applications requiring relatively large sizes or intricate shapes, Ceramagnet Magnets show important cost savings.

Present and potential uses include:

LATCHES • DRIVES • POLE PIECES • DOOR CHECKS SHUNTING CONTACTORS • MAGNETIC CHUCKS MOTOR ROTORS • TOYS • METERS • RELAYS • OIL FILTERS • COUPLINGS • SMALL GENERATORS • MAGNETOS • ION TRAPS • H-F ALTERNATORS • REGULATORS • FOCUSING or DEFLECTING for cathode-ray tubes . . . and dozens of other applications.

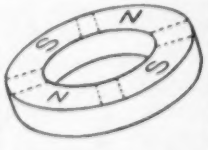
WRITE FOR CATALOG RC-10A

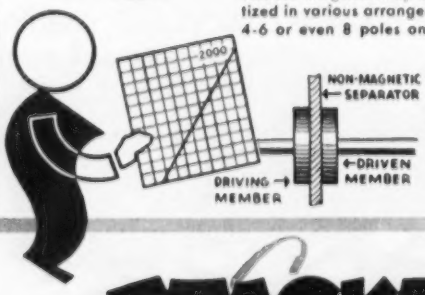
STACKPOLE CARBON COMPANY

St. Marys, Pa.

4 POLES ON ONE FACE

As in this typical magnetic drive unit, Stackpole Ceramagnet permanent magnets may be magnetized in various arrangements with 4-6 or even 8 poles on one face.





A SEALED MAGNETIC DRIVE

Ceramagnet assemblies offer unique possibilities as drives and clutches, including sealed applications where unquestioned magnetic permanency is a "must".

STACKPOLE *Ceramagnet®*

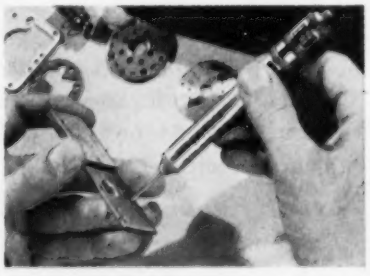
***The Permanent Magnets that are* REALLY PERMANENT**

(Continued from page 38A)

New Products

Recorder. A 2-pen 2-zone recording instrument, ideal for comparative measurement in both the laboratory and on the production line, is now included in the model *6,700* line of recording-controlling instruments manufactured by Weston Electrical Instrument Corp., Newark 12, N. J., a subsidiary of Daystrom, Inc. Although this model *6,791* type 1 recorder is actually two independent instruments in one, it is housed in a case measuring only 17¾ inches wide to fit standard relay racks, and the instrument is of the same simplified, unitized construction which distinguishes the entire line. It employs two electronic amplifiers of special plug-in type for easy servicing, and two separate measuring circuits with replaceable range standards for quick range change on either one or both zones as desired. Alarm switches are available for each zone and can be set in a matter of seconds. Slidewires are interchangeable, and totally enclosed for complete protection. Chart speed available from one inch per hour to 1 inch per minute. Model *6,791* is available with semiautomatic or fully automatic standardization on potentiometer, and is supplied in a dust- and fume-resistant case for universal mounting. Literature giving complete information is available from the manufacturer.

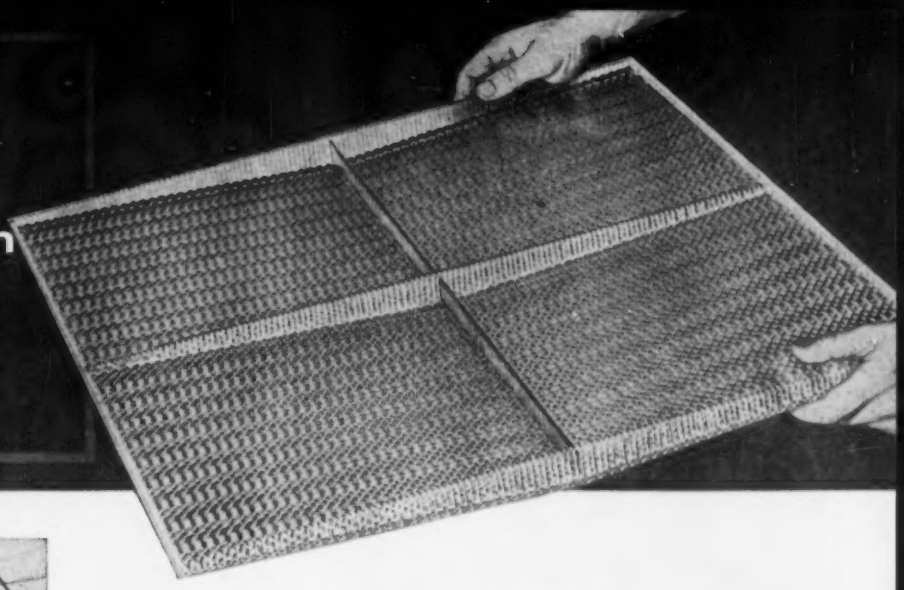
Adjustable Hole Gauge. The Kwik-Chek hole gauge, a precision tool manufactured by the Allied Products Division, Hamilton Watch Company, Lancaster, Pa., permits rapid and highly accurate measurement of small-hole diameters. The device is so simple to use that a child can actually gauge hole diameters in 5 seconds or less. Accuracy and readability of the gauge is 0.0005 inch, the direct reading scale being marked in increments of 0.001 inch, and equipped with a 2.5X magnifying lens. A complete set of three gauges covers hole diameters from 0.025 inch to 0.380 inch,

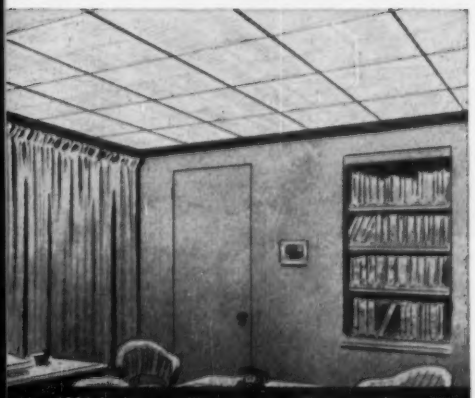


each Kwik-Chek unit having a hole diameter range of 0.125 inch. The gauge is composed of three basic functional parts, a tapered retractable needle, a precision clutch mechanism and an easily-read magnified scale. Hole diameters are measured in four easy steps: needle released by pushing the clutch button, needle inserted in hole, barrel pushed down flush with the piece being measured, and gauge removed and diameter read directly.

(Continued on page 56A)

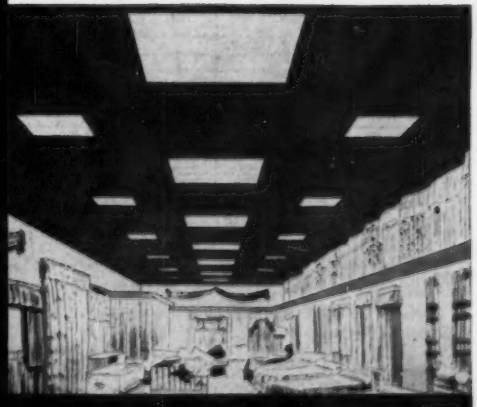
HOLOPHANE ENGINEERS Break Through the GLARE BARRIER...





No. 6024 in large ceiling panels; effective lighting for executive offices.

In 2-foot-wide troffers; emphasizing spaciousness of the bank interior.



Small and large panels in the store ceiling; excellent illumination for seeing and selling.

Prismalume* Controlens* No. 6024 Introduces New Concepts in Fluorescent Light Control

There's a new trend in lighting — heralded by this two-foot-square HOLOPHANE CONTROLENS*. . . It produces the highest illumination with complete visual comfort! With your first step into an interior illuminated by this CONTROLENS you sense that something new and stimulating has been achieved with the lighting . . .

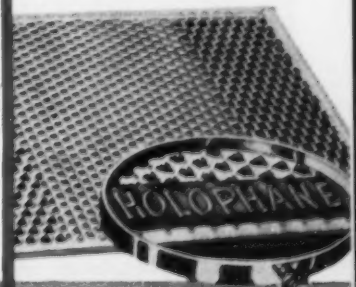
Due to prismatic control, maximum light is delivered on the work plane. This CONTROLENS can be used in two-foot-wide troffers (continuous runs), geometric groupings, or large luminous panels . . . Its sleek, handsome design conforms with the modern decor of offices, banks, stores, lobbies, showrooms, auditoriums and an unlimited variety of other areas. Write for complete engineering data today.

For Better Lighting Holophane *... Be Specific*

*Trademark

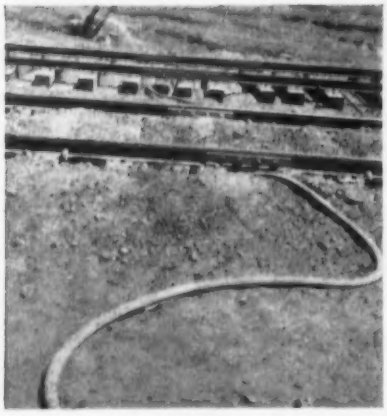
The Name HOLOPHANE *is your Surest Guide to Lighting* QUALITY

High-speed pressing and rolling are cost-cutting ways of making prismatic panels—acceptable only where quality is unimportant . . . This is definitely *not* the Holophane method. Every HOLOPHANE lens is carefully and *individually* pressed on specialized equipment. Only by this painstaking process can we make prismatic forms accurate enough to direct light precisely where it is needed. HOLOPHANE Lenses are the basic components of *custom-engineered* illumination systems, specifically designed for each lighting requirement . . . To be sure of quality in prismatic CONTROLENS* Refractors or Reflectors, look for the name "HOLOPHANE" impressed on each piece.

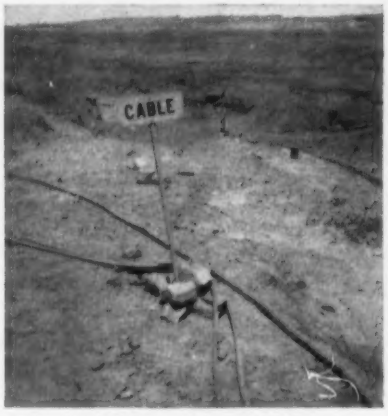


HOLOPHANE
COMPANY, INC. • *Lighting Authorities Since 1898*
342 Madison Ave., New York 17, N.Y.
THE HOLOPHANE CO., LTD., 415 RIPLEY AVE., SO., TORONTO 14, ONTARIO

Over-all view of mine. Each ore car in foreground contains about 60 tons of ore.



Tracks are constantly being moved as pit enlarges. Cables are moved with the tracks.



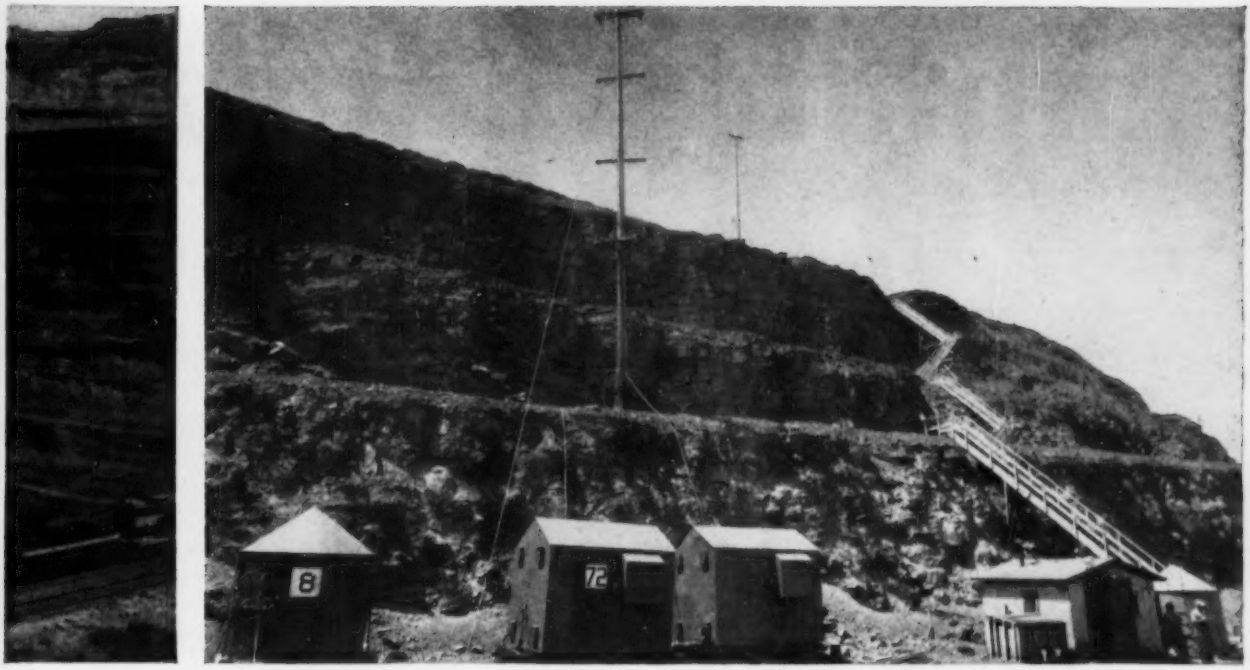
Cables lie in the sun or rain without any protection. They don't need any.

Shovel, being moved, carries 5000 feet of cable with it in the steel box.

Workman manhandles the cable trailing a churn drill as it heads for new location.

Notice long span of this cable bridge and extreme flexibility of cable in foreground.

Shovels lift up to 18 tons in one bite; they operate 24 hours a day.



Entrance poles and meter houses. Cables start from here, work at 440 or 4000 volts.

Iron ore mine finds Tiger Brand Amerclad *in use since 1928*

THE PICTURES show one of the greatest open pit iron ore mines in the world. From pole-head to meter house to shovels and drills, Tiger Brand Amerclad electrical cable serves as a flexible nerve system to supply the huge electrical requirements of machines that operate 24 hours a day in temperatures that range from 100° in the shade to minus 40° in the shoulder-deep snow.

Some of this cable has been in use since 1928, and it's still good.

Other cable is right in the blast area, where it is dragged over sharp rocks and pounded by dynamite-propelled boulders. Even this cable averages six to eight years of useful life.

Look at the pictures and read the captions that tell about operating conditions. You'll see why *no* heavy-duty electrical cable has a greater reputation than Tiger Brand Amerclad. Call your American Steel & Wire representative for the whole story.

AMERICAN STEEL & WIRE DIVISION, UNITED STATES STEEL, GENERAL OFFICES: CLEVELAND, OHIO
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS - TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA., SOUTHERN DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS TIGER BRAND ELECTRICAL WIRE & CABLE

A STANDARD TIGER BRAND CABLE FOR EVERY SPECIAL JOB

- asbestos wire and cable
- mold cured portable cord
- shovel & dredge cable
- paper & lead cable
- varnished cambric cable
- interlocked armor cable
- special purpose wire & cable
- aerial, underground and submarine cable

USS

UNITED STATES STEEL

ENGINEERING and

From the Chart...

DETAILS DESCRIBING SOME OF THE PROFESSIONALLY SIGNIFICANT POSITIONS

SENIOR COMPONENT APPLICATION SPECIALIST

Salary to $12,000

This position requires an Electrical Engineering Degree with at least six years' electronic design experience. This experience should include the application of components, such as: transformers, relays, resistors, capacitors, semiconductors and rotary equipment. You must have the ability to counsel and guide young engineers lacking broad technical experience. The position is located in pleasant suburban Moorestown, New Jersey, adjacent to Philadelphia.

OPERATIONS ANALYST

Salary to $12,000

Join an operations research group in evaluating the air defense mission. Areas of effort include: search and development problems; probability studies to determine missile and aircraft weapons systems effectiveness using Monte Carlo differential gain theory and other techniques; evaluation of ground control systems, kinematic studies using a high speed digital computer.

Advanced degree or equivalent in math, physics or engineering. Minimum 3 to 5 years' experience. Position at Airborne Systems Laboratory, Waltham, Mass.

TRANSDUCER DEVELOPMENT ENGINEER

Salary to $12,500

Interesting position for Acoustical Engineer to work with small group in design and development of devices and systems. Prominent in the microphone and transducer field, RCA has interesting work in the following areas: headsets, and loudspeakers; noise and vibration measurement and analysis, speech compression systems, noise cancellation microphones, psychoacoustics. RCA has facilities ideal for the man who desires advanced work. Position is located in Greater Philadelphia area at Camden, New Jersey.

INFRARED SYSTEMS ENGINEER

Salary to $15,000

Engage in overall coordination and design of infrared systems for Airborne Fire Control Defense and Missile Guidance. You should be experienced in general performance specifications, servo design, displays, infrared heads and optical systems. You also must be capable of giving technical guidance to Junior Engineers. Minimum of 5 years' experience necessary. EE or Physics degree. The location is Camden, New Jersey, in the Greater Philadelphia area.

EQUIPMENT DEVELOPMENT ENGINEER—MECHANICAL

Salary to $11,500

Opportunity for work of advanced development nature in areas of receiving tubes and semiconductors. Conception, design and development of prototype equipments. Education, background and experience in mechanization, and related fields required. Knowledge of electromechanical systems desirable. Air-conditioned area, with complete shop and laboratory facilities. Position at Harrison, N.J. . . . 30 minutes from N.Y.C.

MANAGER MICROWAVE TUBE ENGINEERING

Salary—Open

Supervise fifteen engineers and technicians investigating application problems and development of new applications for Microwave tubes. Work with equipment customers and field personnel on Microwave tube applications. Preparation of new technical data and specifications. Supervision of laboratory test sections in performance of life, design, and environmental tests. Located at Harrison, N.J. . . . 30 minutes from N.Y.C.

COMMUNICATION DEVELOPMENT ENGINEER

Salary to $12,500

An ideal opportunity for a development engineer. Work in Advanced Development Information Handling and Control Group. Develop techniques for application to PCM for voice and data transmission. Work will involve development of both digital and analog transistor circuits for application to pulse cone modulation voice and data transmission systems. One to two years' experience in digital and/or communication techniques is required. EE or Physics degree. Location in Camden, New Jersey, in Greater Philadelphia area.

ELECTRONICS TEST ENGINEER—MICROWAVE

Salary to $11,000

Interesting opening for a top quality, creative man to design and develop electronic test equipment for evaluation of magnetrons and traveling-wave tubes. Microwave and pulse circuit background required. Work will be in development of measurement techniques and adaptation to developmental and production tube testing. The right man will find exceptional opportunities for advancement. Located at Harrison, N.J., just 30 minutes from mid-town Manhattan.

TRANSMITTER DESIGN SUPERVISOR

Salary to $14,000

This position requires a BSEE and eight to ten years' experience in High Power UHF or VHF television transmitter design. You should be capable of supervising a small group of design engineers and providing technical and administrative direction for the group. If you possess this experience and are looking for an opportunity to advance, you are invited to visit RCA, in suburban Moorestown, New Jersey.

Modern benefit program . . . relocation expenses paid . . .

SCIENCE at RCA

STARTING SALARIES: NON-MANAGERIAL TO $15,000 ... MANAGERIAL OPEN

FIELDS OF ENGINEERING ACTIVITY		MANAGERS	TYPE OF DEGREE AND YEARS OF EXPERIENCE PREFERRED											
			Electrical Engineers			Mechanical Engineers			Physical Science			Ceramics Glass Technology Metallurgy		
			0-2	2-3	4-15	0-2	2-3	4-15	1-2	2-3	4-15	1-2	2-3	4-15
• **SYSTEMS** (Integration of theory, equipments and environment to create and optimize major electronic concepts.)	AVIATION ELECTRONICS • CONTROLS		W	W	W C	W	W	W C	W	W	W C			
	DIGITAL DATA HANDLING DEVICES	M C		M C	M C		C	C		C	C			
	MISSILE WEAPONS SYSTEMS • RADAR	M W	W	M W X C	M W X C	W	M W C	M W C	W	M W X C	M W X C			
	INERTIAL NAVIGATION			W C	W C		W C	W C		W C	W C			
	COMMUNICATIONS		C	C N	C N	C	C				C N			
• **DESIGN • DEVELOPMENT** **MISSILE WEAPONS SYSTEMS**—Planning and Design—Radar—Fire Control—Servomechanisms—Computers		C M	W C M X	W C M X	W C M X	W C M	W C M	W C M X	W C M	W C M X	W C M X			
AVIATION ELECTRONICS—Radar—Computers—Servomechanisms—Shock and Vibration—Circuitry—Remote Control—Heat Transfer—Sub-Miniaturization—Automatic Flight—Automation—Transistorization—Infrared—Airborne TV		W C	W C X	W C X	W C X	W C	W C X	W C X	W C X	W C X	W C X			
RADAR—Circuitry—Antenna Design—Servo Systems—Gear Trains—Intricate Mechanisms—Fire Control—Information Handling—Displays		M C	W M C X	W M C X	W M C X	W M C X	W M C X	W M C X	W M C X	W M C X	W M C X			
COMPUTERS—Systems—Advanced Development—Circuitry—Assembly Design—Mechanisms—Programming—Digital Data Handling Devices		M	C W	M C X W	M C X W	C	M C X W	M C X W	C W	M C W	M C W			
KINESCOPES (B & W and Color), OSCILLOSCOPES—Electron Optics—Instrumental Analysis—Solid States (Phosphors, High Temperature Phenomena, Photosensitive Materials and Glass to Metal Sealing)			L	L Y	L Y	L	L Y	L Y	L	L Y	L Y	L	L Y	L Y
RECEIVING TUBES—Tube Design—Test and Application Engineering—Chemical and Physical Development—Methods and Process Engineering—Advanced Development			H	H	H		H	H		H	H		H	H
SEMICONDUCTORS—Transistors—Semiconductor Devices—Materials			V	V	V	V	V	V	V	V	V	V	V	V
MICROWAVE TUBES—Tube Development and Manufacture (Traveling Wave—Backward Wave—Magnetron)		H	H	H	H		H	H		H	H		H	H
GAS, POWER AND PHOTO TUBES—Photosensitive Devices—Ceramic to Metal Sealing—UHF and VHF—Super Power			L	L	L	L	L	L	L	L	L	L	L	
COMMUNICATIONS—Specialized Systems—Microwave—Mobile—Aviation—Audio—Propagation Studies—Acoustics—Transducers			C N	C N	C N		C	C	C N	C N	C N			
BROADCAST AND TV—Monochrome and Color Studio Equipment—Cameras—Monitors—High Power Transmitters			C	C	C	C	C	C	C	C	C			
• **SYSTEMS APPLICATION** (Evaluation and Planning—Design and Development—Modification—Specification)														
MISSILE TEST INSTRUMENTATION (Data Acquisition and Processing)—Radar—Telemetry—Timing—Communications—Optics—Computers		F	F S	Z F S	Z F S	F S	F S	Z F S	F S	Z F S	Z F S			
RADAR—Airborne—Surface—Shipboard—Sonar—Fire Control		F	F S	Z F S	Z F S	F S	F S	Z F S	F S	Z F S	Z F S			
COMMUNICATIONS—Radio—HF—VHF—UHF—Microwave—Telephone—Teletype—Telegraph Terminal Equipment—Wave Propagation		F	F S	F S	F S	F S	F S	F S	F S	F S	F S			
• **MACHINE DESIGN** Mechanical and Electrical—Automatic or Semi-Automatic Machines			L H	L H	H	L	L H	H		L	L			

Locations: **C**—Camden, N. J. **F**—Cocoa Beach, Fla. **H**—Harrison, N. J. **L**—Lancaster, Pa. **M**—Moorestown, N. J. **N**—New York, N. Y. **S**—RCA Service Co. (Cherry Hill, N. J.; Alexandria, Va.; Tucson, Ariz.; Dayton, Ohio; San Francisco, Calif.) **V**—Somerville, N. J. **W**—Waltham, Mass. **X**—West Los Angeles, Calif. **Y**—Marion, Ind. **Z**—White Sands, N.M.

Please send resume of education and experience, with location preferred, to:

Mr. John R. Weld, Employment Manager
Dept. A-14-C, Radio Corporation of America
30 Rockefeller Plaza, New York 20, N.Y.

RCA

RADIO CORPORATION of AMERICA

Tmks. ®

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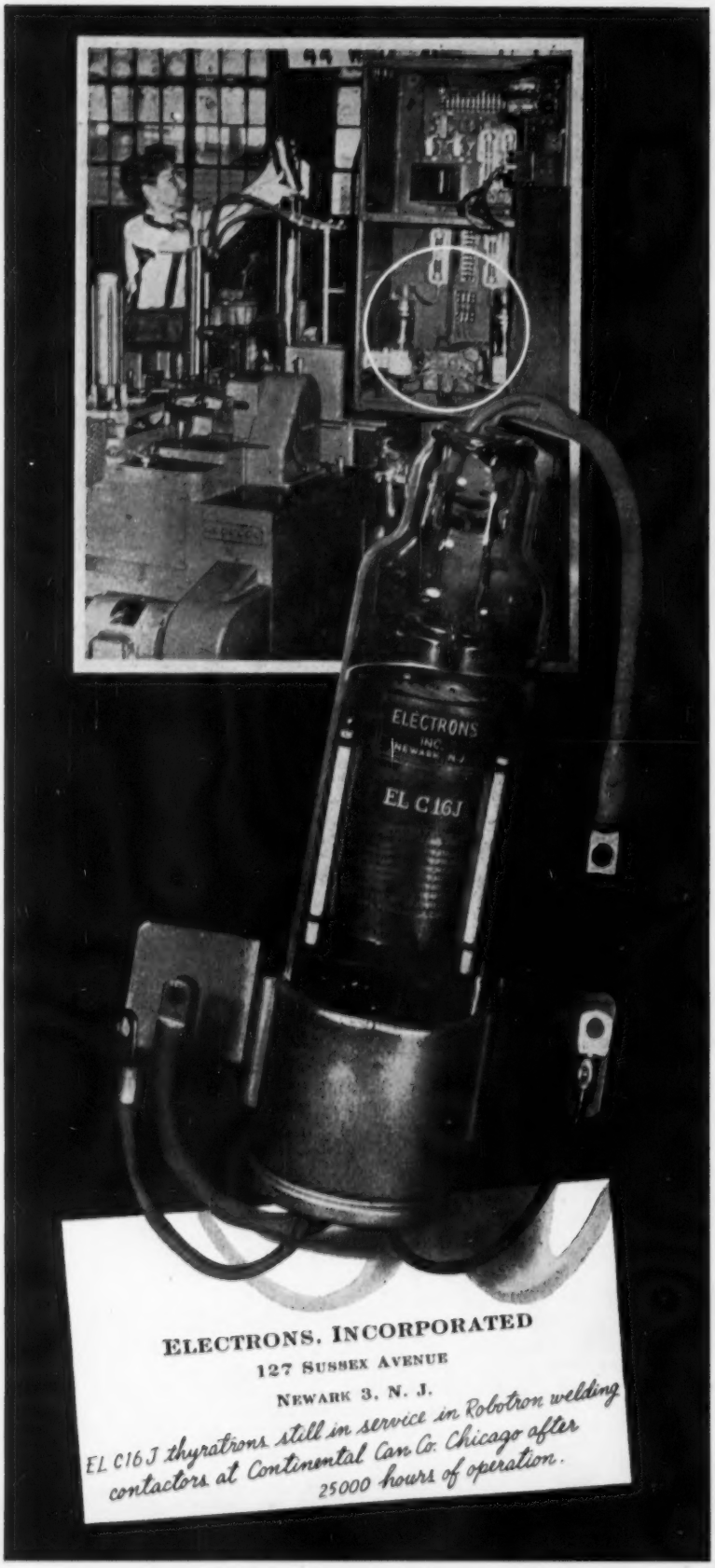
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INC.
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EL C16J
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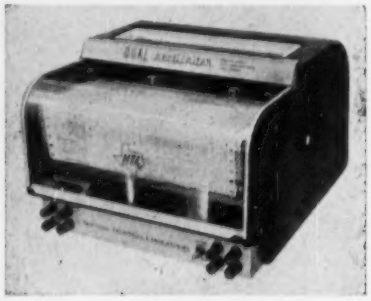
127 SUSSEX AVENUE
NEWARK 3, N. J.
EL C16J thyratrons still in service in Robotron welding contactors at Continental Can Co. Chicago after 25000 hours of operation.

(Continued from page 50A)

New Products

Two-Channel Rectilinear Recorder. Two functions can be monitored simultaneously in their true wave forms with the rectilinear writing galvanometric strip chart recorder announced by the Industrial Instrumentation Division of Texas Instruments Incorporated. The dual "recti/riter" uses a single chart drive and records the two variables on a two channel rectilinear chart with a common time base. The instrument has high deflection sensitivity and is adaptable to a variety of circuits. As the instrument has galvanometer meter movements, it is economical and



highly reliable, with no warmup time or drift problems. Functional design features which make the dual recti/riter highly convenient are a "writing desk" area for manual notations on the chart, front-located zero adjust, front-mounted controls and signal terminals, and finger-tip 10-speed gear shift chart drive. Marker pens can be mounted on each side of the chart. For additional information on the dual recti/riter, write to Texas Instruments Incorporated, Industrial Instrumentation Division, P.O. Box 6027, Houston, Tex.

Milling Machines. Development of high-speed automatic milling machines suitable for slicing and dicing germanium ingots for the transistor manufacturing industry is announced by the W. H. Nichols Company. These millers are of the rise and fall spindle type with speeds up to 10,000 rpm available. An automatic mist lubrication system is provided for spindle bearings and antifriction overarm-type arbor support. Diamond impregnated sawing discs up to 8 inches in diameter can be accommodated. Automatic transverse feed of 6 inches, adjustable in increments from 0.001 inch to 0.085 inch, is synchronized with automatic pneumatic feeds of spindle head and table for high-speed continuous slicing cycles. All feeds are air actuated. Motors and all rotating members are precision balanced to avoid vibration. Present users claim that maximum production rates and high accuracy are maintained. Complete information can be secured from The Robert E. Morris Company, West Hartford 7, Conn., national distributors of Nichols Milling Machines.

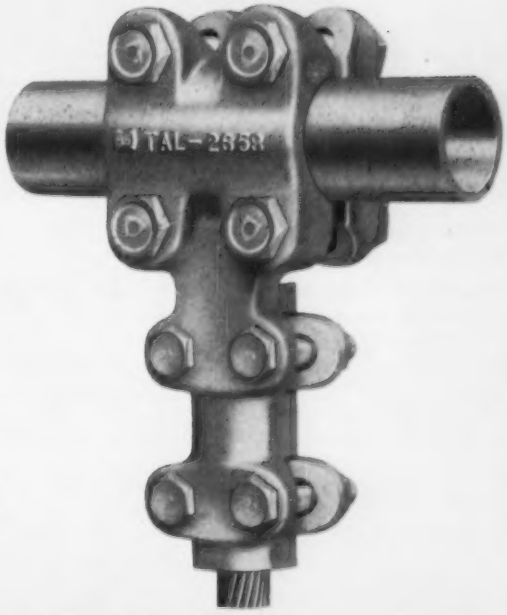
(Continued on page 75A)

BRONZE OR ALUMINUM FITTINGS BY SOUTHERN STATES

Today, there is available from Southern States a wide choice of fittings in either bronze or aluminum. In addition to standard items, special designs can be quickly supplied to meet specific customer requirements.

Southern States aluminum connectors have exceptional cross-sectional strength, extra-large areas of contact engagement, and recessed self-retaining bolt heads. Like their bronze companions, they are fully capable of: 1) serving as self-supporting members; 2) providing a good electrical connection; 3) developing the full strength of clamping bolts without visible distortion; 4) carrying the current of the conductor without excessive temperature rise; and 5) being installed with a minimum of effort and time.

Specify Southern States fittings for the best protection at every connection.



NEW! SOUTHERN STATES ALUMINUM CONNECTOR CATALOG NOW AVAILABLE

SOUTHERN STATES
EQUIPMENT CORP.
HAMPTON, GEORGIA

IN CANADA
Dominion Cutout Co., Ltd., Toronto

New exclusive KEARNEY 0-51 and 0-52 Tools

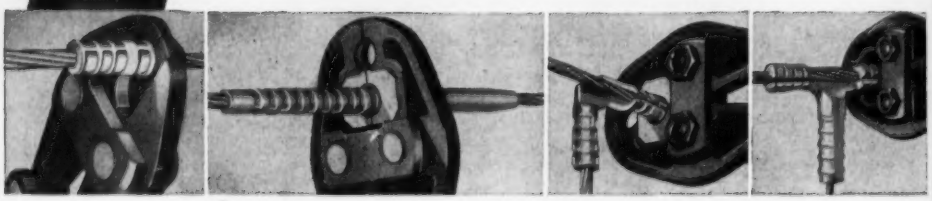
Out-perform all others!

Exclusive "Snap in-Snap out" Dies for faster installation of compression sleeves and fittings in widest size-range!

Another Kearney engineering first. . . and exclusive! New, low-cost 0-51 and 0-52 lever-action Tools make most distribution connections—install widest size range of compression sleeves and fittings. Extra speed and convenience because Kearney original "snap in-snap out" insert dies can be interchanged with two-finger ease! Lightweight, rugged construction. Write today for Bulletin 13.

Dies lock in place!

No tools needed. Self-aligning die halves "snap in-snap out." Utmost rigidity: each die part locks in rectangular seat by a shoulder and groove, is held in place by spring locking pins.



These connections can be made with 0-51 and 0-52 Tools:

SQUEEZONS—up to and including 4/0 ACSR, or stranded
L-TAPS—up to and including 2 ACSR, or stranded
T-TAPS—1/0 ACSR, or stranded
SERV-ENS—up to and including 1/0 ACSR, 4/0 stranded
SLEEVES—up to and including 4/0 stranded aluminum, 2/0 ACSR and stranded copper

Extra size range!

Fixed die in jaw nose installs Serv-Ens and L-Taps. Insert dies available to install sleeves and Squeezon fittings for most wire sizes used in distribution systems. Dies positioned close to fulcrum pins so minimum effort is needed on the tool handles. Wire cutter blades, also available, snap into same seat as the dies.

for BETTER CONSTRUCTION
SAFER MAINTENANCE
Specify KEARNEY

JAMES R KEARNEY CORPORATION ST. LOUIS MO. SUBSIDIARY

The Mark of Quality PRODUCTS

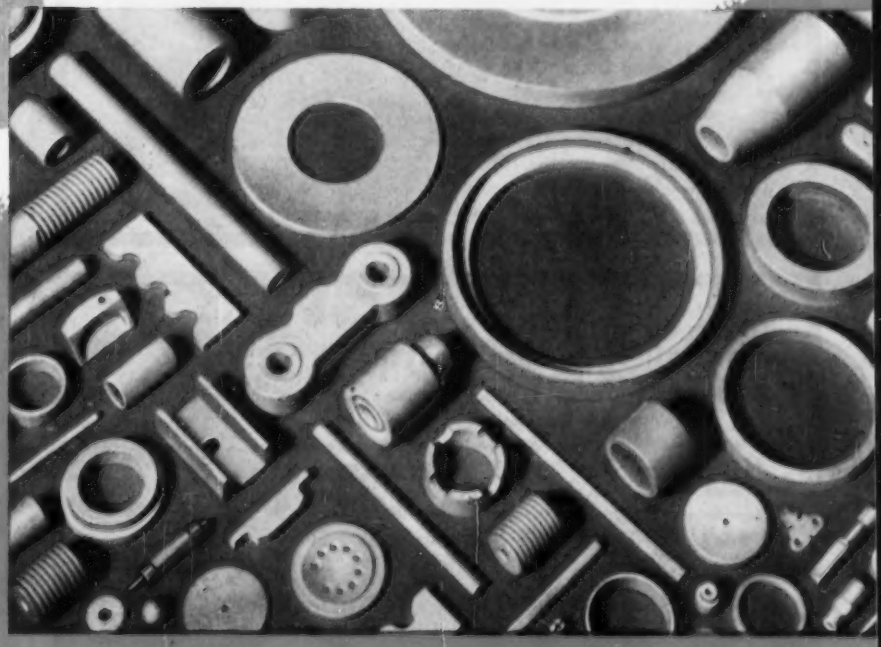
four good reasons for specifying AlSiMag® alumina ceramics!

1 Highly specialized compositions. Complete range of industry-approved AlSiMag Aluminas for exacting applications. New freedom in design from their outstanding performance at elevated temperatures and frequencies . . . superior electrical characteristics . . . higher compressive, tensile and flexural strengths . . . hardness (9 on Mohs' scale) . . . chemical inertness . . . greater resistance to impact, vibration, abrasion and repeated thermal shock. Custom formulations for special needs.

2 More production facilities. Complete manufacturing facilities devoted exclusively to AlSiMag Aluminas, including special high temperature kilns. Rapid delivery in any quantity . . . simplest to most intricate designs. Precision tolerances.

3 More experience. AlSiMag Aluminas are produced by skilled personnel, thoroughly familiar with the most modern methods . . . and highly specialized techniques perfected in over 55 years' experience in the manufacture of quality technical ceramics.

4 Dependable metal-ceramic combinations. Standard or custom designs available in volume. Wide choice of metals combined with strong, rugged Alumina ceramics. Permanent bonding. Close dimensional tolerances. High or low temperature types . . . for hard or soft solder.



For complete information on AlSiMag Aluminas, for your application, send blueprint or sketch with details of your operating procedure.

Ask for a free copy of Bulletin No. 562—AlSiMag Alumina Ceramics.

AMERICAN LAVA CORPORATION
A SUBSIDIARY OF MINNESOTA MINING AND MANUFACTURING COMPANY
CHATTANOOGA 5, TENN.
55TH YEAR OF CERAMIC LEADERSHIP

For service, contact Minnesota Mining & Manufacturing Co. Offices in these cities (see your local telephone directory): Atlanta, Ga. • Boston: Newton Center, Mass. Buffalo, N. Y. • Chicago, Ill. • Cincinnati, O. • Cleveland, O. • Dallas, Texas Detroit, Mich. • High Point, N. C. • Los Angeles, Calif. • New York: Ridgefield, N. J. • Philadelphia, Pa. • Pittsburg, Pa. • St. Louis, Mo. • St. Paul, Minn • So. San Francisco, Calif. • Seattle, Wash. Canada: Minnesota Mining & Manufacturing of Canada, Ltd., P. O. Box 757, London, Ont. All other export: Minnesota Mining & Manufacturing Co., International Div., 99 Park Ave., New York, N. Y.

NEW

high level performance pressure transducers

by BOURNS

- *High vibration performance*
- *Temperature compensation*
- *Expanded measurement ranges*
- *High reliability*

An entirely new concept in pressure instrument performance combined with Bourns' experience in fine instrument manufacturing.

MODEL 409
Absolute Pressure Transducer

. . . a new design which provides extremely accurate performance characteristics. An advanced mechanism results in low vibration sensitivity for high vibration levels over all pressure ranges.
Temperature compensation and optimum material selection result in negligible temperature effect over a wide temperature environment.
Available ranges: 0-2 psia to 0-100 psia.

Write for Bulletin 409

MODEL 509
Differential Pressure Transducer

. . . a new design with the same *quality plus* features as the Model 409. The diaphragm capsules manufactured by Bourns provide exceptional hysteresis and linearity performance in addition to the low temperature error. These production instruments are assembled and tested to exacting quality standards.
Available ranges: 0-2 psi to 0-100 psi.

Write for Bulletin 509

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BOURNS LABORATORIES, INC.
General Offices: 6135 Magnolia Ave., Riverside, Calif.
Plants: Riverside, California—Ames, Iowa

TRIMPOT ® • LINEAR MOTION POTENTIOMETERS • PRESSURE TRANSDUCERS AND ACCELEROMETERS

VISIT OUR BOOTHS #3716-18 I.R.E. SHOW

Power Supply for Resistance Welding Machines
(April 1952)

AIEE Special Publication S-45 is a report of the AIEE Subcommittee on Power Supply for Resistance Welding Machines. Recognizing that the installation and use of any resistance welding process vitally concerns not only the industrialist requiring the process but also the welding machine manufacturer and the utility supplying the electric power as well, the committee has in this report brought together much pertinent data from the knowledge, literature, and experience in all these fields.

This publication supersedes the AIEE reports of the same title presented in 1940-1. The new work is required by developments in welding machines, new processes, better analysis of certain phenomena (such as measurement of instantaneous loads, and interference between welders), and a clearer understanding of the whole problem of power supply for resistance welders.

This report is not intended to be a complete solution of all welding problems, but should direct attention to the special electrical features involved so that a full analysis developed for a welding project can be readily understood and utilized by manager, master mechanic, and electrical engineer.

Copies are available for the price of $1.00 (no discounts permitted). Address:

Order Department
AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS
33 West 39th Street
New York 18, N. Y.

3-57

Tie it . . . clamp it . . . the conductor carries the current, but the *porcelain* insulates it from ground. Lapp builds the Line Post with either type of conductor head for maximum convenience of installation . . . and it builds the *porcelain* to do the *insulating* job. The porcelain in either case is a closed-end post, of high density vacuum-process electrical porcelain. It won't puncture because it has no conductive material within it. It outperforms any other type of insulator in dirt conditions because its fog-type design prevents leakage flashover from non-uniform leakage resistance. It stands up under arcover, stones and bullets because its short, sturdy petticoats protect the body. And it won't crack because its hardware, both top and bottom, is *externally* attached, and can load porcelain only in compression.

With tie-wire or clamp-top, the Lapp Line Post will give you an *extra* margin of operating security, low upkeep, long life.

Lapp Insulator Co., Inc., Le Roy, N. Y.

Lapp

connect with CANNON PLUGS

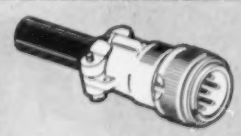
for better electrical and electronic equipment

USE for AIRCRAFT and ELECTRONIC INSTRUMENTS

TYPICAL DESIGNS

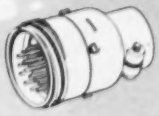
AN, AN-A, AN-B, AN-C...Conforming to Specification MIL-C-5015C. 15 insert diameters and 260 contact layouts. 6 shell styles, AN3100 to AN3108 with all accessories. Also (AN) F, O(*)AF.

for VIBRATION RESISTANCE and MOISTURE-PROOF applications



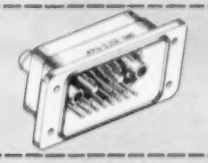
AN-E SERIES . . . environment resisting. Replaces AN-M. Meets Specification MIL-C-5015C. Resilient inserts. Integral cable clamp. New grounding lugs. Interfacial sealing, improved grommet and new grommet follower.

for GENERAL CIRCUITRY and QUICK DISCONNECT in more rugged applications



K, RK SERIES . . . SPECIAL ACME THREAD. The All-Purpose Series. Conduit and cable clamp entry types. 1 to 82 contacts in 213 different contact layouts. 10-, 15-, 30-, 40-, 60-, 80-, 115-, and 200-amp. silver-plated contacts. High quality phenolic, melamine, and formica insulators. Cadmium-plated aluminum alloy shells.

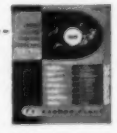
for UNIT-PLUG-IN applications . . .



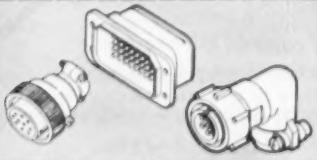
DP, DPB, DPD, DPD2, DPD2R, DPJ, AND DPS SERIES . . . Rack/panel/chassis. With and without shells; coaxial and high voltage contacts. Permit quick disconnect, interchange, replacement, testing and inspection of assemblies and sub-assemblies.

for AUDIO and LOW LEVEL circuits

P, XLR, XL, XK, O, UA, BRS SERIES . . . many shell styles and insert layouts. Straight and angle 90° plugs. Latch-lock types. Wall-mounting, panel, locknut mounting, and adapter receptacles, single- and two-gang. 10- to 30-amp. contacts, coaxials. UA Series features 3 gold-plated contacts.



for RADIO and SUB-MINIATURE applications



D, MC, DPA, DPX, AND K MINIATURES . . . miniatures and sub-miniatures designed for amplifiers, miniature indicators, computer circuits, telemetering equipment, small pre-amps, and general instrumentation where space is limited and current requirements are generally not over 5 amperes. Variety of shell styles, junction shell, and insert arrangements. 3 to 50 contacts, plus coaxials.

for HERMETICALLY SEALED applications

GS (AN TYPE), KH, RKH, DAH, BFH, TBFH, DBH, KH30 . . . with steel shells and contacts to withstand high pressures from within or without. Insulation is a glass material, fused under high temperature to shell and contacts, thus forming a hermetic seal.

for HIGH TEMPERATURE and firewall applications

AN-K, AN-"FW," AND CANNON K-"FW" STEEL SHELL CONNECTORS . . . Open flame protection offered in the greatest variety of this type of connector. Wall- or box-mounting receptacles. Straight or angle 90° plugs. Crimp-type contacts. Inserts of glass-filled materials.

Send for AR Condensed Catalog containing illustrations and technical information on all principal series of connectors in the extensive Cannon Line.

CANNON ELECTRIC COMPANY, 3208 Humboldt St., Los Angeles 31, California. Factories in Los Angeles, Salem, Mass., Toronto, Can., London, Eng., Melbourne, Austl. Manufacturing licensees Paris, Tokyo. Representatives and distributors in all principal cities.

please refer to Dept. 117

CANNON ELECTRIC

Since 1915

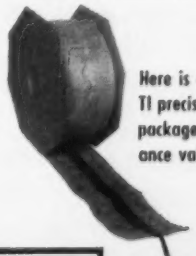
TI MIL-Line Precision Resistors

HOLD TOLERANCE...EVEN WHEN DRIPPING WET!

Soaking wet, dried out, or 'shook up' – TI MIL-Line deposited carbon resistors still far exceed MIL-R 10509B . . . emerge from one acceptance test after another – by major electronics manufacturers – with performance records that have not been equalled. *It's the seal that makes the difference* . . . an exclusive Texas Instruments process that snugly wraps these precision resistors in tough jackets of a special coating with high dielectric strength.

For ease in design, production, and maintenance . . . for improving the reliability and saleability of your products, the moisture resistance of TI deposited carbon MIL-Line resistors is just *one* field-proven factor. You also get a choice of 1, 2, or 5% tolerances . . . high stability over wide temperature ranges and under full load . . . low negative temperature coefficients . . . negligible voltage coefficient and noise levels . . . long shelf-life . . . wide selection of sizes and resistance values . . . reasonable prices . . . and, if desired, reel-type packaging for automation.

Visit our booths No. 2816 to 2820 at the 1957 I.R.E. Show, New York



Here is a typical TI reel pack designed to speed production. TI precision deposited carbon resistors are mass produced and packaged in five sizes from ½ watt to 2 watts with resistance values from 25 ohms to 30 megohms.

For complete data, write for Bulletin DL-C 539.

TEXAS INSTRUMENTS
INCORPORATED
6000 LEMMON AVENUE DALLAS 9, TEXAS

HOW TO PREVENT FAULT CURRENT

OR CURRENT LIMITATION Vs. OR Amp-trap® Vs. Circuit Breakers—

Amp-trap Form 480

ARCING AND BOLTED FAULT DANGER

Available short circuit currents increase with the growth of system capacity. Some network systems can now deliver more than 100,000 Amperes R.M.S. at feeder duct points and over 50,000 Amperes R.M.S. on plug-in duct. This means that maximum protection against fault currents of high or low magnitudes can be obtained only through a protective device that will *instantly* de-energize the circuit. *Amp-trap* is such a device because its patented† construction gives microsecond response to fault currents of any magnitude.

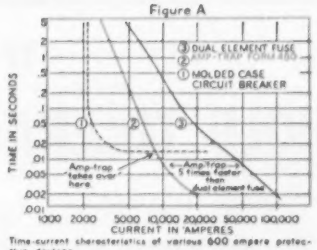
CONVENTIONAL PROTECTION

Circuit breakers* and dual element fuses may be adequate to open at 100,000 Amperes R.M.S. but they are so slow that fault currents build up to their maximum peaks of destruction before they can open. Conventional circuit protective devices just aren't fast enough or sensitive enough to stop the build-up of fault currents to their maximum peaks of destruction. Consequently, busways, panelboards and switch gear are destroyed by magnetic distortion, arcing and burning.

Amp-trap® PROVIDES POSITIVE PROTECTION

Amp-trap, on the other hand, *anticipates* the build-up of enormous available fault currents, and limits them to low values. It prevents destruction by clearing the circuit in a fraction of the time it takes for a circuit breaker's contacts to open, or for a dual element fuse to blow. As shown by the curves in Figure A, dual element fuses are even slower than circuit breakers. Along with standard One-Time and Renewable fuses, they can no longer be seriously regarded as adequate protection against magnetic and thermal demolition.

Figure A


TIME IN SECONDS
3 DUAL ELEMENT FUSE
2 AMP-TRAP TOWLER
1 MOLDED CASE CIRCUIT BREAKER
Amp-trap takes over here
Amp-trap 5 times faster than dual element fuse
1000 2000 5000 10,000 20,000 50,000 100,000
CURRENT IN AMPERES

Time-current characteristics of various 600 ampere protective devices.

Amp-trap® BEST BY TEST

Recent tests on bus duct prove *Amp-trap* protects two ways: (1) against heavy fault currents (2) against arcing faults. Sustained arcs, the most elusive of all system hazards, travel fast along bus-bars and burn to destruction as they go. The AIEE paper 56-46, February 1956, "Short-Circuit Protection of Busway Systems with Current Limiting Fuses," by Cataldo and Shackman of Bulldog Electric Products Company, proves *Amp-trap's* protective ability against both arcing faults and bolted faults. At the same time, it proves that neither circuit breakers nor dual element fuses can protect apparatus against either low or high magnitude faults.

Similar bus duct tests by other manufacturers confirm *Amp-trap's* superiority.

NOTHING TAKES THE PLACE OF Amp-trap®

Mere interrupting capacity in a circuit breaker* or fuse does not protect apparatus from fault current destruction. Only current-limiting *Amp-trap* or *Amp-trap* protected circuit breakers can do this. They alone have current limiting ability and almost unlimited interrupting capacity, as well as the sensitivity needed to prevent arcing faults. The following tests prove this.

®*Amp-trap* is a registered trade name of The Chase-Shawmut Co. and refers to a current limiting device and herein is written *Amp-trap*.

*All circuit breakers except the I-T-E Cordon with integral Amp-traps or others with coordinated Amp-trap protection.

†*Amp-trap* is covered by one or more of the following patents: 2,557,926; 2,592,399; 2,594,315; 2,599,646; 2,647,970; 2,653,203; 2,658,974; 2,662,140; 2,665,348; 2,670,418; 2,681,398; 2,703,352; 2,713,098; 2,734,110; 2,734,111; 2,734,112; 2,740,187; 2,740,735.

DAMAGE TO BUSWAY SYSTEMS

INTERRUPTING CAPACITY

Dual Element & Standard Fuses

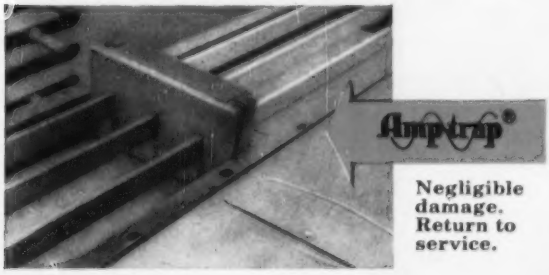
Amp-trap Form 480

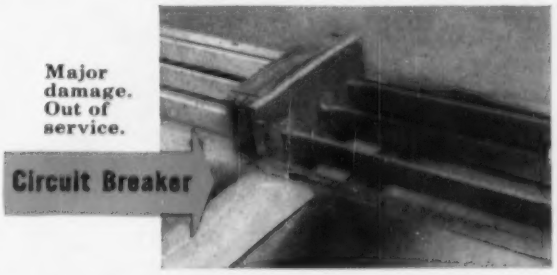
ARCING FAULT TESTS

(Low Current Tests)

Three-phase 480 volt arcing fault tests on 200 Ampere bus duct with ¼″ x 1″ bus-bars. Insulators spaced on 20″. Arc started by bridging bus with fine fuse wire. Circuit Breaker rating: 600 Amp., 600 Volts, 3 Pole, Int. Cap. 50,000 Amps., R.M.S.

Amp-trap Form 480, 800 Amp., 600 Volts — *4 times normal bus-bar current rating, blows only on fault currents.*





Protection	Available Fault Current RMS	Peak	Max. Let-Through Current	Duration of Fault Cycles	Busway Burning Damage	Condition
Circuit Breaker	20,500	31,000	31,000	3.1	Major	Out of service
Amp-trap	20,500	31,000	21,000	.73	Negligible	Return to service

BOLTED FAULT TESTS

(High Current Tests)

Three-phase bolted fault tests on 200 Ampere bus ducts with ¼″ x 1″ bus-bars, insulators spaced on 24″ centers, case energized by connection to center bus.

Circuit Breaker rating: 600 Amp., 600 Volts, 3 Pole, Int. Cap. 50,000 Amps., R.M.S.

Amp-trap Form 480, 800 Amp., 600 Volts — *4 times normal bus-bar current rating, blows only on fault currents.*

Protection	Available Current RMS	Peak	Max. Let-Through Current Peak	Fault Duration Cycles	Avg. Max. Deflection	Distortion (Permanent Set)	Condition
Circuit Breaker	35,000	51,800	51,800	2.00	1.125″ Arced to case	1.125″	Out of service
Amp-trap	35,000	51,800	24,000	.27	.10″	0.″	Return to service

For further information on *Amp-trap*, get in touch with us here at Newburyport.

AMP-TRAPS – "Ounce At The Switch"

THE CHASE-SHAWMUT CO.

273 MERRIMAC STREET • NEWBURYPORT, MASSACHUSETTS

Subsidiary of I-T-E CIRCUIT BREAKER CO., Philadelphia, Pennsylvania

Est. 1893

Represented in Canada by Powerlite Devices, Inc.

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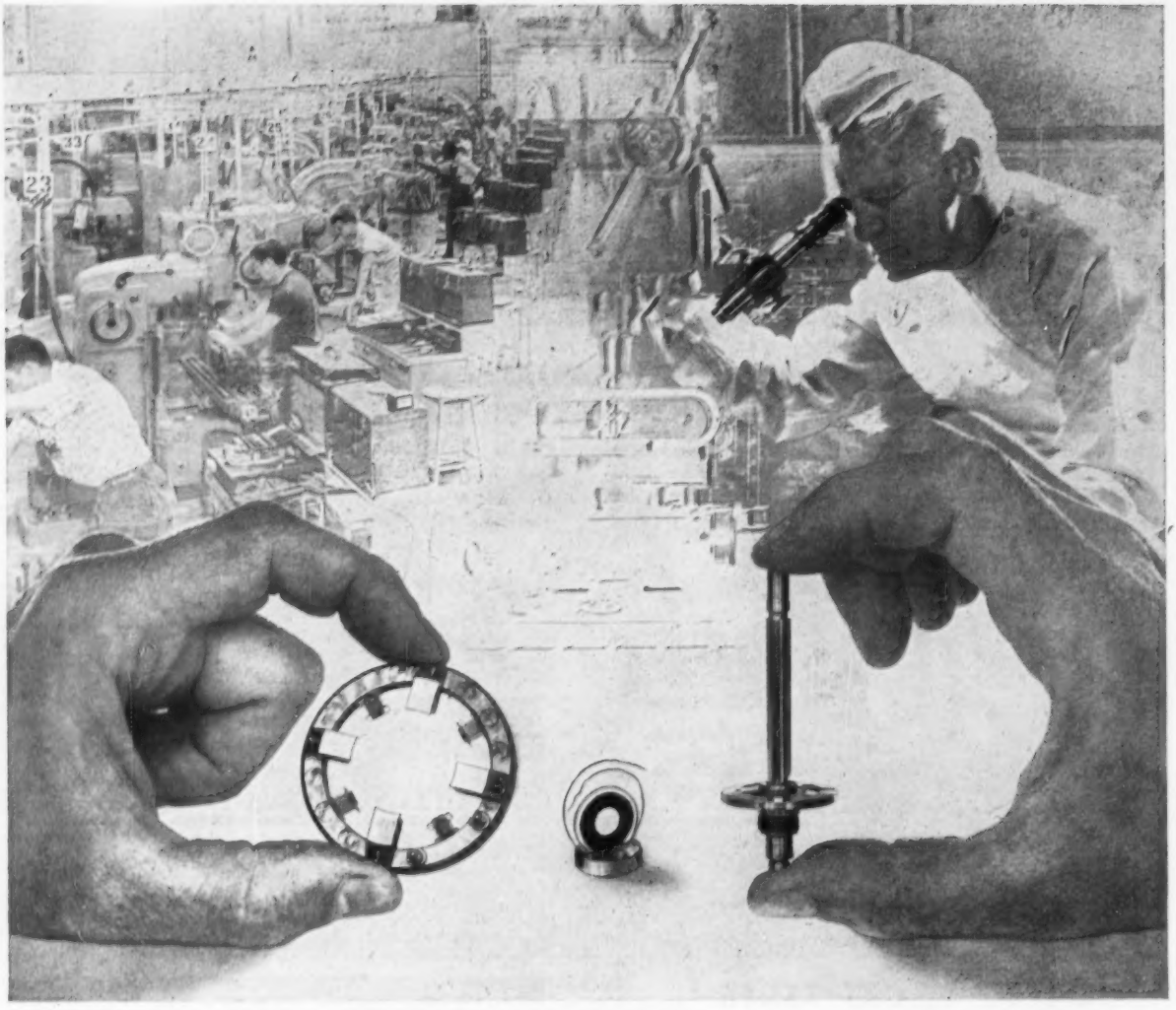

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Lights burn and wheels turn when the magic of electricity surges through industry's life line of high voltage cable. Long, intensive testing has proved beyond question that Simplex ANHYDREX XX insulated cable possesses the stability and resistance that assure long, trouble-free service in all environments. Its amazing resistance to ozone and other oxidizing agents make Simplex ANHYDREX XX the logical choice for your high voltage applications. For complete technical data write for Booklet 1023.

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- ✔ TOROIDAL CORES
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We'll welcome your inquiries on your Tape Wound Core requirements for Pulse and Power Transformers, 3-Phase Transformers, Magnetic Amplifiers, Current Transformers, Wide-Band Transformers, Non-Linear Retard Coils, Reactors, Coincident Current Matrix Systems, Static Magnetic Memory Elements, Harmonic Generators, etc.

ENGINEERING DATA

For data on the various types of Arnold Tape Cores, write for these Bulletins:

TC-107—*Silectron Cores, Types C, E and O*
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How to be *sure* of tape core performance and uniformity? Just specify and use *Arnold* Cores in your transformer, magnetic amplifier, reactor and computer assemblies, etc.

Here's why!

To begin with, Arnold is a fully integrated company, controlling every manufacturing step from the raw material to the finished core. Then, modern testing equipment permits 100% inspection of cores before shipment. Finally, you're matching your requirements against the most experienced and complete line of tape cores in the industry. Arnold produces Types C, E and O Silectron cores, nylon and aluminum cased toroidal cores, and bobbin cores to meet whatever your designs may require in tape thickness, material, core size or weight. Wide selections of cores are carried in stock as standard items for quick delivery: both for engineering prototypes to reduce the need for special designs, and for production-quantity shipments to meet your immediate requirements.

Let us help you solve your tape core problems. Check Arnold, too, for your needs in Mo-Permalloy or iron powder cores, and for cast or sintered permanent magnets made from Alnico or other materials.

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the NEW AMPlivar splice plus new horizontal machine

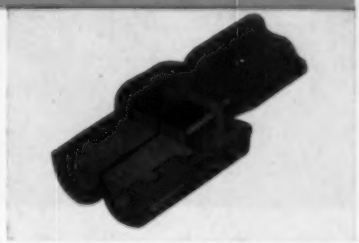
for identical, mass produced splices of enamel, poly-vinyl acetal and similarly coated wire

AMPlivar splices can be used on solid or stranded conductors, or combinations thereof.

AMPlivar splices, with multiple ring stripping action, eliminate scraping, dissolving in solvents, burning, or other methods for removing insulation. Included among its many other features are:

- NO HEAT DAMAGE TO WIRE OR INSULATION—as often occurs in alternate methods of splicing.
- SMALL SIZE—scarcely larger than the wires themselves, but design-engineered to lock wire and connector into a high tensile strength splice.
- CORROSION RESISTANT—the joint is hermetically sealed during splicing.
- LOWER INSTALLED COSTS—eliminates soldering materials and equipment . . . requires less wire . . . reduces time required to make the splice.

Further information is available on request.



This cutaway of the AMPlivar splice shows how conductor material extrudes outwardly into serrations for added strength and electrical contact. The splice is as corrosion resistant as the wire itself.

IDEAL FOR ASSEMBLY LINE PRODUCTION . . . the AMP Horizontal Automachine uses AMPlivar splice connectors in strip form, for automatic splicing as fast as the operator can insert the wires.

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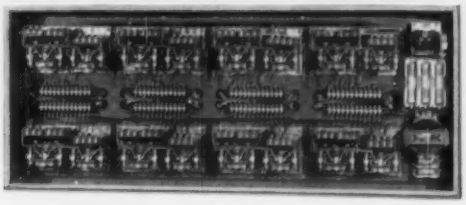
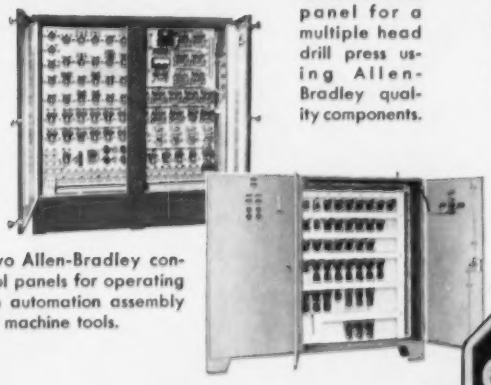


Motor control panel for a multiple head drill press using Allen-Bradley quality components.



Two Allen-Bradley control panels for operating an automation assembly of machine tools.

When the control panel furnished with your production machine carries the Allen-Bradley trademark of QUALITY, your customer's approval is assured! That is why so many leading machinery builders have standardized on Allen-Bradley controls. The "simple design" of all Allen-Bradley controls is your guarantee of trouble and maintenance free service.

No matter how complex your control requirements may be, as specialists in this field, Allen-Bradley's experience may be of valuable assistance to you. Call your nearest A-B office.

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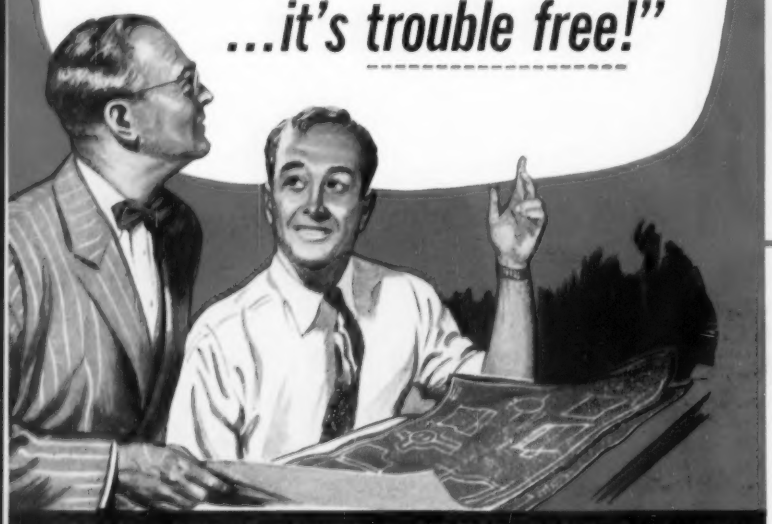
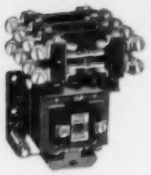
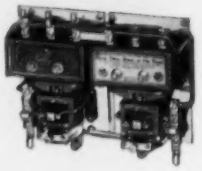


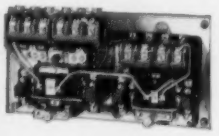
SPECIFY THESE RELIABLE MOTOR CONTROL UNITS



Bulletin 700
Universal Relay with
N.O.—N.C. Contacts

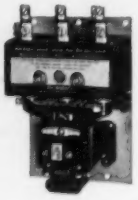


Bulletin 705 Size 2
Reversing Starter

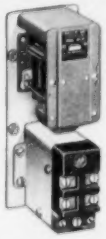


Bulletin 715 Two
Speed Consequent
Pole Starter

Bulletin 802T Adjustable
Lever Oiltight Limit
Switch



Bulletin 702 Three Pole
Size 2 Contactor



Bulletin 849 "On-Delay"
Pneumatic Timer

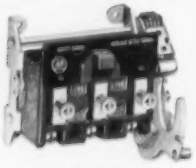
Bulletin 892
Handy Terminal
Blocks

Bulletin 704, Mechanically
Held, Hum-free Relay

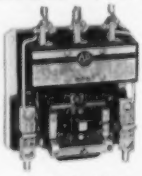
Bulletin 200
D-C Relay

Bulletin 350
Reversing Drum Switch

Bulletin 836
Pressure Control in
NEMA Type 4 Enclosure

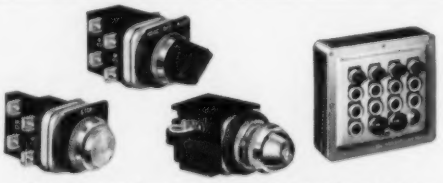


Bulletin 894
Visible Blade
Disconnect Switch



Bulletin 709
Size 4 Automatic
Starter

Bulletin 609
Three Phase
Manual Starter



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Allen-Bradley *quality* components assure you millions of trouble free operations. The simple design, maintenance free, double break, silver alloy contacts, and rugged design features have made them the first choice among design engineers, contractors, and maintenance men. You just can't go wrong with this QUALITY line.

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CAN BE INSTALLED ANYWHERE. Here workers begin to feed RoZone-RoSeal cable into conduit inside underground vault of St. John's Hospital. This versatile cable can be used anywhere—in the air, in conduit and ducts, direct in earth, even in water.

EASY TO PULL. Workers at the new St. John's Hospital in Tulsa draw Rome's easy-pulling high-voltage cable from underground switch vault to surface and power transformers. The hospital's architect recognized *all* the advantages of RoZone-RoSeal (see his letter below).

Profit from this architect's experience with Rome's premium high-voltage cable

LEON B. SENTER, A.I.A.
ARCHITECT
306-7 PHILTOWER BLDG.
TULSA, OKLAHOMA

November 28, 1955

Regarding our choice of RoZone-RoSeal cable for St. John's Hospital:

We can tell you that due to the nature of the building, extreme reliability was the first consideration.

Closely following were the requirements of moisture resistance, inductive capacity in the configuration as laid, and uniformity of product.

We found that a specification built around Rome Cable's RoZone-RoSeal satisfied all the above.

Very truly yours,

LEON B. SENTER, A.I.A.

John C. Penafeather

John C. Penafeather
Mechanical Engineer

JCP:lz

He wanted the same things you probably want in a high-voltage cable: reliability, moisture resistance, the right electrical characteristics, and uniformity. He found them all in Rome Cable's RoZone-RoSeal.

You can use this cable anywhere—in the air, in conduit and ducts, buried in earth, *even in water*. Here's how it compares with most conventional thermosetting nonmetallic cables:

- Costs less.
- Greater resistance to moisture and comparable resistance to abrasion, crushing, impact, chemicals, and oils. oils.
- Easier pulling and bending. The RoSeal (polyethylene) jacket has a lower coefficient of friction than any other jacket material. And it bends easily at temperatures as low as −40° C.
- High corona levels on power cables.

Rome Cable's RoZone-RoSeal met this architect's rigid specifications, and it can meet yours, too.

Specify RoZone-RoSeal for your next job. Contact your nearest Rome Cable representative for more information—or write to Department 702 and ask for Bulletin ROT-1. Rome Cable Corporation, Rome, New York.

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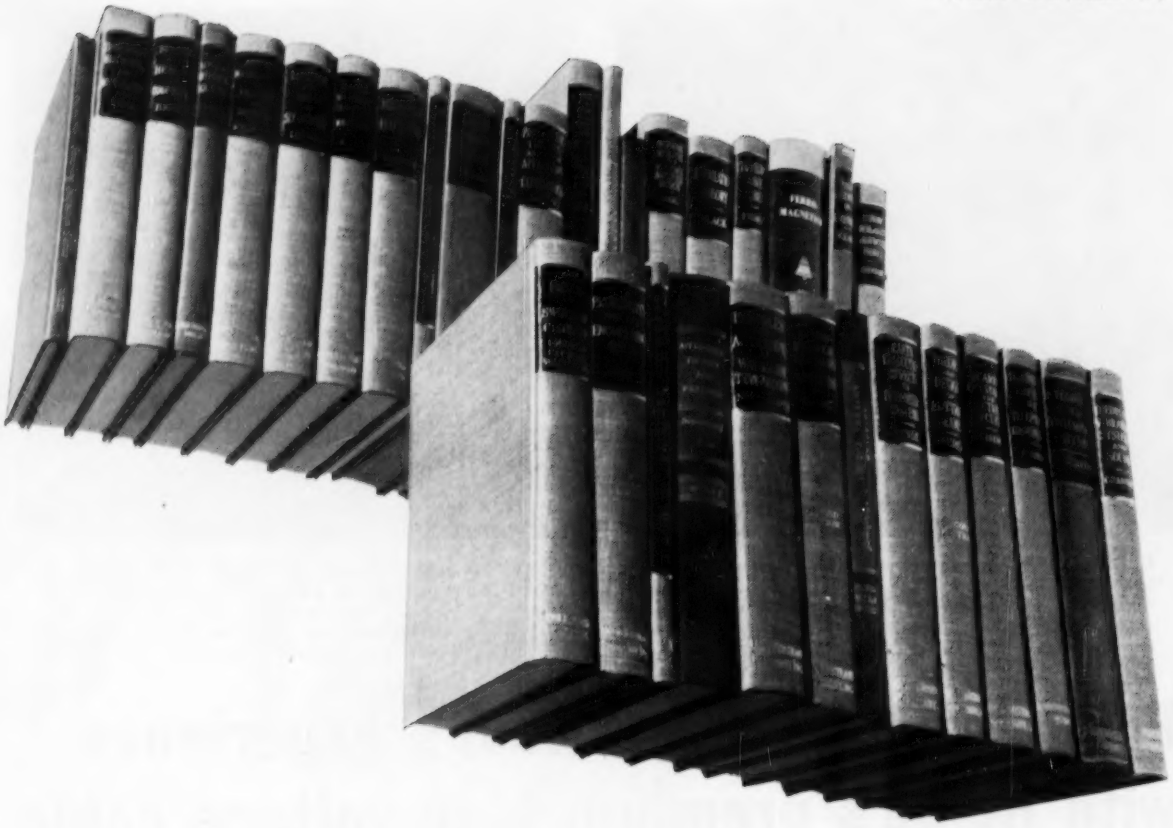
The books...



How the scientific world shares in fruits of the telephone art

In their work to improve telephony the scientists and engineers of Bell Telephone Laboratories make important findings in many sciences. They thoroughly report these findings in professional journals and magazines. But sometimes, as knowledge accumulates in a vital field, a "treatment in depth" is prepared in book form.

Bell Laboratories authors have written 36 books to date and others are in preparation. Many have become classics in the Laboratories' primary field of communications. Many have become standard works of wide application because they provide a fundamental guide for technologies in other fields. For example, the design of automatic switching systems is of primary importance in computers; statistical quality control provides the indispensable basis for economical manufacture. Through their books these scientists and engineers and the Laboratories attempt to repay benefits they receive from the published works of others.

The pictures on the opposite page show some Bell Laboratories authors of technical books. A complete listing of titles may be obtained by sending in this coupon.

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John R. Pierce, Ph.D., California Inst. of Tech., author of "Traveling-Wave Tubes."

Richard M. Bozorth, Ph.D., California Inst. of Tech., author of "Ferromagnetism."

W. Thornton Read, M.S., Brown University, author of "Dislocations in Crystals."

Hendrik W. Bode, Ph.D., Columbia University, author of "Network Analysis and Feedback Amplifier Design."

Walter A. Shewhart, Ph.D., University of California, author of "Economic Control of Quality of Manufactured Product."

(Continued from page 56A)

New Products

Resistor. A card-type wire-wound resistor, type *1300*A, has been put on the market recently. This encapsulated, wafer-thin, card-type resistor is designed specifically for applications where limited space prohibits the use of the usual cylindrical bobbin-type, precision wire-wound resistors. It is especially adaptable for circuits using transistors, in guided missiles, and airborne communication and navigation equipment. Originally designed for tinker-toy type modules, they are also available as multisection card-type resistors. Additional data on the new card-type resistor can be obtained from E. Grayson, The Daven Co., 530 West Mt. Pleasant Ave., Livingston, N. J.

Graphitic Brushes. Performance of the *D* series of brush grades under adverse conditions has been fully proved by the Ohio Carbon Company. Unnoticed, tough physical, and atmospheric conditions might gradually reduce commutator efficiency. The *D* series grades are characteristically electrographitic lamp black brushes of the highest quality manufactured primarily for modern d-c motors and generators. The series is distinguished by universally high contact drop, low friction, and good carrying capacity, as claimed by the company. The grades of this series are recommended for modern a-c and d-c heavy-duty traction, locomotive, mill, mine, crane, elevator, and electric shovel motors, as well as for general service on almost all d-c generators and synchronous converters. The series possesses high commutation factor for severe commutating conditions. For further information request catalog No. *72-D* from The Ohio Carbon Co., Dept. 72, 12508 Berea Road, Cleveland 11, Ohio.

Small Wall Model Heater. A line of smaller wall model electric home heaters is now available from Westinghouse Electric Corporation. The heaters answer the need for smaller heating units in homes, apartments, schools, and offices. The nine flush-mounted home heating units, rated from 1,000 to 6,000 watts, operate on 240-volt a-c. The height of the wall opening required to install the heaters is 18¼ inches. The width of the opening varies from 9½ to 27¾ inches. The wall depth is 3⅞ inches. The heaters normally heat by radiation and convection. Where convected heat alone is desired, an aluminum baffle blocks out infrared rays. A simple bimetal thermostat automatically maintains the desired temperature in any room. Heating elements are guaranteed against burnout for 10 years. All models are finished in gray baked enamel with an aluminum grille. For further information, write Westinghouse Electric Corporation, P. O. Box 2099, Pittsburgh 30, Pa.

(Continued on page 78A)

American Standard
LETTER SYMBOLS
for
ELECTRICAL QUANTITIES

This American Standard (Z10.5—June 1949), which has been prepared by a subcommittee of the Sectional Committee on Letter Symbols and Abbreviations for Science and Engineering, is a revision of ASA Z10g1 and AIEE 17g1.

General principles of letter symbol standardization, a typographical notation for distinguishing, in the equations of the printed page, between the symbols for scalar, complex (phasor), and vector quantities are given, as well as tabulations of the symbols in alphabetical order of the names of quantities, English letter symbols, and Greek letter symbols.

Price: $0.60. Address orders to:

AIEE
ORDER DEPARTMENT
33 West 39th Street
New York 18, N. Y.

0-57

Missile Designers:

JACK & HEINTZ OFFERS YOU 3 TYPES OF

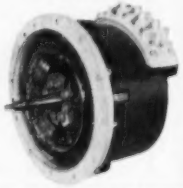
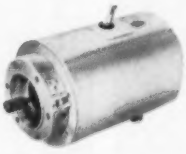
Environment-Free Generators

J&H machines deliver full-rated output independent of speeds, ambients, altitudes

In answer to the electric power needs of such weapons as North American's *Navaho* and Boeing's *Bomarc*, Jack & Heintz has successfully developed three approaches to the design of environment-free generators for missiles. With many completed units within each classification, J&H is in a position to meet quickly the requirements of missiles of all types: SSM SAM ASM AAM AUM UAM USM UUM.

Short-Duration Flights: J&H *thermal lag* generators are capable of delivering full-rated output throughout flight without benefit of cooling.

Long-Duration Flights: J&H *vapor-cooled* and *oil-cooled* generators using water and engine or hydraulic oil as coolants will deliver full-rated output regardless of speeds, ambients or altitudes.

Representative J&H Generator Designs for Missiles	Vapor-Cooled	Oil-Cooled 	Thermal Lag 
J&H Model	G188-5	31190-005	31186-001
Nominal Rating (kva)	30	40	10
Duty	continuous	continuous	intermittent
Volts	120	120/208	120/208
Speed (rpm)	12,000	6,000	12,000
Phase	3	3	3
Frequency (cps)	400	400	400
Power Factor (minimum)	.8	.75	.9
Weight (lb)	66	75	29.5
Length (in.)	13	9	10
Diameter (in.)	9	9.75	7

To Meet Your Specific Needs: J&H missile power specialists are available to confer on your specific requirements . . . generators and regulators. You may obtain basic engineering data on other J&H environment-free generators by writing to Jack & Heintz, Inc., 17622 Broadway, Cleveland 1, Ohio. Export Department: 13 East 40th Street, New York 16, New York.

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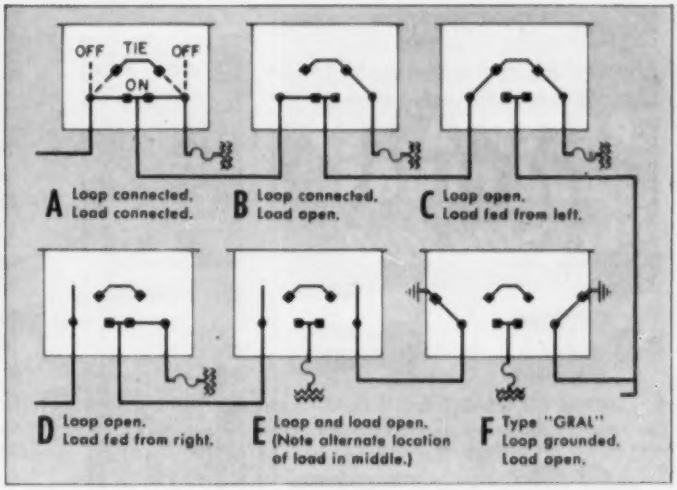
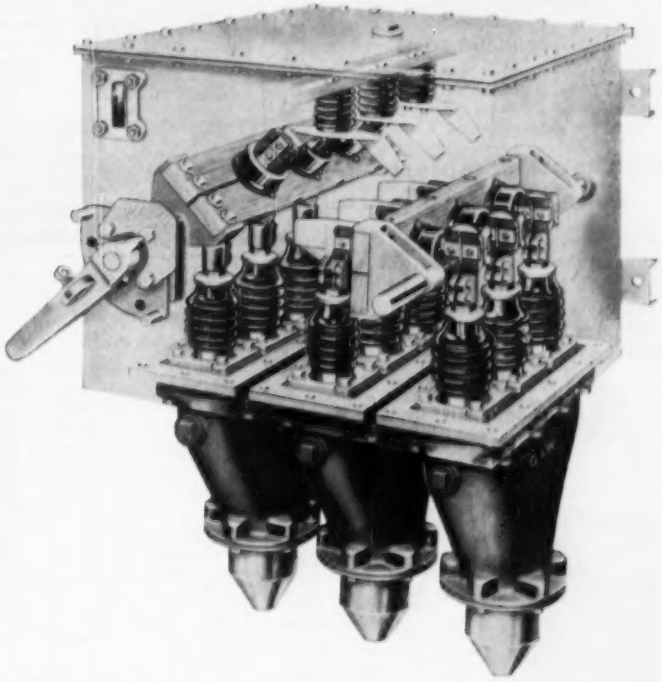
JACK & HEINTZ AIRCRAFT ELECTRIC EQUIPMENT


OFF
TIE
OFF
ON
A Loop connected. Load connected.
B Loop connected. Load open.
C Loop open. Load fed from left.
D Loop open. Load fed from right.
E Loop and load open. (Note alternate location of load in middle.)
F Type "GRAL" Loop grounded. Load open.

Provide distribution system F-L-E-X-I-B-I-L-I-T-Y with G&W Type "RAL" *LOAD BREAK* OIL SWITCHES

Type "RAL" oil switches with three ways (2 feeder and 1 load), two sets of links, and tie buses are designed for use on loop circuits and in other situations where similar flexibility would otherwise require three separate oil switches with correspondingly greater expense for equipment, installation, and space.

The diagrams above show six of the connections possible with the "RAL" switch. The novel link arrangement permits the loop to be connected through the switch with or without the load connected—it permits the load to be connected to either side of the loop with the other side disconnected—and it permits any section of the loop to be isolated (and grounded) without interrupting service to any of the branches. The load cable can be terminated in the middle (either feeder can be grounded) or in either of the outer cableheads (load can be disconnected without interrupting loop).



Standard "RAL" switches are made in 400 ampere (full load break) rated 600, 7,500 & 15,000 (illustrated) volts. Special designs for 23,000 and 34,500 volts and for 1000 amperes.

Send for series "D" bulletins.

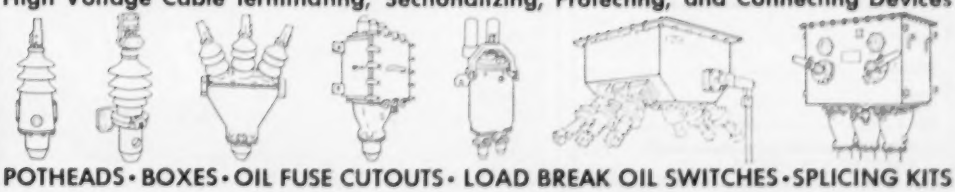
Type "RAL" switches are combined into special units with "FC" OIL FUSE CUTOUTS or with POWER FUSES to save equipment cost, installation labor, and space.

G&W ELECTRIC SPECIALTY COMPANY
3500 W. 127th ST., BLUE ISLAND, ILLINOIS

Representatives in many cities of U. S. A., N. & S. America — Canadian Mfr. – Powerlite Devices, Ltd., Toronto, Montreal & Vancouver — D571

G&W

High Voltage Cable Terminating, Sectionalizing, Protecting, and Connecting Devices



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Quick-Flexible
Plug-in Connections
for Power Distribution

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SOCKET RECEPTACLE & PIN PLUG

Sizes from 10 to 250 Ampere Capacity. Receptacle Cap in 14 colors — Plug handles in red or black.

PIN RECEPTACLE & SOCKET PLUG

Sizes from 25 to 250 Ampere Capacity. Receptacle Cap in 14 colors — Plug handles in red or black.

BINDING POSTS

Dead Front — Designed to bind spade lugs, solid or stranded wires. Accommodates standard banana plugs, and Plug Binding Post for stacking multiple connections. Sizes to 500 Ampere Capacity.

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Plug-in connections for test or production equipment are safe and sure with Flexlab Receptacles and Plugs. Widely used for over thirty years by industry, government, schools and universities in

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Production Test Benches
Laboratory Test Apparatus

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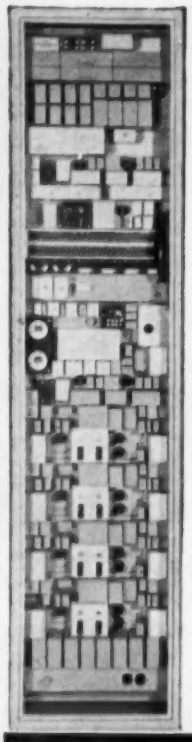
☐ *Please have engineer call to discuss specific requirements — no obligation.*



FOUR-CHANNEL OPEN-WIRE CARRIER-TELEPHONE SYSTEM.

This is a high-grade long-haul system compatible with three-channel type C, OA-11/FC and OA-12/FC systems. The fourth toll-grade channel has been obtained by advanced filter and oscillator-network design without changing the frequency allocation or degrading the performance of the three carrier channels or of the physical circuit. Transmission in one direction is in the band 3.4 kc to 15.65 kc, and in the other direction in the band 17.95 kc to 31.4 kc. On copper conductors repeater sections average 200 miles, and high-grade circuits several thousand miles in length can be maintained under all climatic conditions.

Type AN/FCC-10 Carrier-Telephone Terminal manufactured for the U.S. Army Signal Corps. This terminal includes regulated-tube rectifiers, d-c telegraph composite sets, line protectors, operator's telephone set, 4-wire terminating sets, v-f signal converter type CV-399/FCC, and all accessories to form a complete packaged 4-channel terminal. It is moisture- and fungus-proofed, and meets all applicable MIL specifications. It is a-c operated.

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Telephone: UNiversity 6-6887 Cable Address: Radenpro, Montreal
MANUFACTURERS OF CARRIER-TELEGRAPH, CARRIER-TELEPHONE AND BROAD-BAND RADIO SYSTEMS

(Continued from page 75A)

New Products

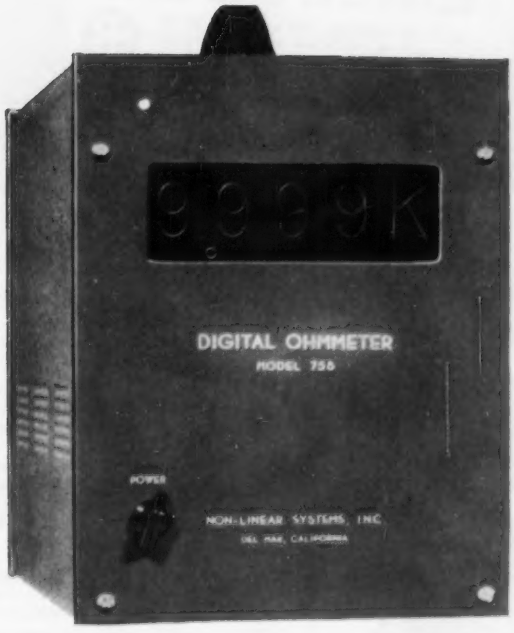
Circuit Boards Coating. No. *391F* flux coat, a material for protecting printed circuit boards against corrosion during storage has been developed by Alpha Metals, 56 Water St., Jersey City, N. J. This material, a mixture of rosin and quick drying nonblush solvents, can be applied after etching and cleaning copper printed circuit boards. Alpha No. *391F* can be applied either by brushing or spraying, and will dry in approximately 20 minutes to a hard, nontacky, varnish-like finish. Because No. *391F* Flux Coat is compatible with flux used in the final dip soldering operation, it is never necessary to remove the protective coating.

Filters. *HQ* series filters are extremely stable sharp-cutoff high-attenuation vhf band-reject filters. They have a wide tuning range and constant bandwidth. These units afford an easy means of improving band edge response of broad-band filters or amplifiers. Their narrow bandwidth allows them to be used to eliminate narrow band cochannel interference. These traps are particularly well suited for use in removing adjacent channel interference to color television signals. *HQ* series units are built in two bandwidth ranges. The *HQT* has a peak attenuation greater than 70 db and 30 db bandwidth of 200 kc. The *HQF* has a peak attenuation greater than 90 db and a 30 db bandwidth of 400 kc. They are available with various connector types, matched to maintain minimum voltage standing wave ratio. Current models *HQT-26* and *HQF-26* are tunable in the range of 50 mc to 100 mc and model *HQT-77* is tunable in the range of 174 to 220 mc. For further information contact Entron Incorporated, 4902 Lawrence St., Bladensburg, Md.

Thermostat. The *Klixon C6786* is a snap-acting disc-type temperature control designed for aircraft controls, electronic circuits and components, servomechanisms, gyroscopes, aerial cameras, guided missiles, gun mounts, or where high shock and vibration resistance is required. The snap-acting Spencer disc thermal element and fine silver electric contacts are enclosed with a stainless-steel cup for full protection. The base assembly is available in phenolic or silicone construction. Accurate operating temperatures range from −20 F to +400 F. Temperature settings are factory preset, either standard range or special, as required by the application. Miniature size makes the *C6786* particularly suitable where space and weight accommodations are limited. Terminals are solder type. Individual setting, tolerance, differential, and terminal configuration requirements will be given special consideration. A technical bulletin is available; inquiries are invited. Write to Metals & Controls Corporation, Spencer Thermostat Division, Attleboro, Mass.

(Continued on page 82A)

FAST...PRECISE...AUTOMATIC RESISTANCE MEASUREMENTS FOR LABORATORY OR INDUSTRY



Models 758 and 759 available in either rack mount or portable. Portable model is pictured above.

FAST, AUTOMATIC MEASUREMENT of a wide range of resistance values, with an exceptionally high degree of accuracy, now is available in Non-Linear Systems Digital Ohmmeters. Resistance values are displayed in a horizontal line on one-inch-high luminous numerals clearly legible at distances to 30 feet. The readout decimal point location and range selection are automatic. And these instruments feature the exclusive NLS *oil-sealed stepping switches*, specifically re-designed for NLS digital equipment. This feature has been time-tested in the widely accepted NLS Model 451 Digital Voltmeter; it guarantees maximum maintenance-free life of stepping switches even in the presence of dust and humidity. Accuracy, ruggedness, high-speed automatic operation, reliability and economy adapt NLS Digital Ohmmeters to a wide variety of applications in laboratory, production, inspection and field testing...even with unskilled personnel. Ask your nearest NLS representative about these instruments...or mail the coupon below for full details.

CHARACTERISTICS

Model 758 (4-Digit Display)

RANGES: .0001K to .9999K, 1.000K to 9.999K, 10.00K to 99.99K, 100.0K to 999.9K, 1000K to 9999K

ACCURACY: ±0.1% of value read or 1 digit, whichever quantity is greater.

Model 759 (5-Digit Display)

RANGES:	ACCURACY:*
0.0001K to 9.9999K	±(0.01% +1 digit)
10.000K to 99.999K	±(0.01% + 1 digit)
100.00K to 999.99K	±(0.03% + 1 digit)
1000.0K to 9999.9K	±(0.05% + 1 digit) to 5 meg. ±(0.1% + 1 digit) to 10 meg.

*Percentages are expressed as % of value measured

BOTH MODELS

RANGE SELECTION & DECIMAL LOCATION: *Automatic*

SIZES: *Rack Mount—5¼" H, 19" W, 15¼" D. Bench Top (Portable)—11" H, 8¼" W, 15¼" D.*

WEIGHT: *33 lbs*

PRIMARY POWER: *115±10v, 60 cycles, 75 watts.*

ACCESSORIES: *Data printing provision with automatic print control and Clary Printer or Electric Typewriter.*

Connection and automatic control for card or paper tape punching equipment.

Multi-channel input scanners.

non-linear systems, inc.
Del Mar, Calif. • Phone: SKyline 5-1134

ORIGINATORS OF THE DIGITAL VOLTMETER

Digital Ohmmeters • AC-DC Converters • Data Reduction Systems • Digital Readouts • Peak Reader Systems • Binary Decimal Converters Digital Recording Systems

NON-LINEAR SYSTEMS, INC.
Dept. A-126, Del Mar Airport, Del Mar, Calif.

Send new Technical Bulletin 1256 with full information on NLS Digital Ohmmeters—Models 758 and 759.

NAME_____

COMPANY_____

ADDRESS_____

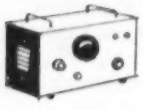
CITY_____ STATE_____

heat resistant?

right with . . .

CONTINENTAL

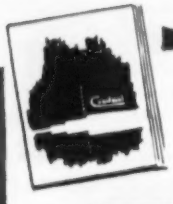
insulated wire and cable



SILICONE RUBBER APPLIANCE WIRE For radio and electronic wiring. Heat, cold, moisture are beat. Retains dielectric and physical properties in temperatures ranging from −67°F to +392°F. Resists flame, solvents, oils.

MACHINE TOOL WIRE Heat and oil resistant wire. Standard 600 v insulation availdble in sizes 18 AWG to 4/0. Extra heavy insulation: sizes 14 AWG to 8. UL listing 90°C in air; 60°C in oil.

ELECTRIC STOVE WIRE — AIA For safe wiring of commercial electric grills, ranges, space heaters, water heaters and other heavy duty appliances. Maximum operating temperature: 257°F. Heat and flame resistant.



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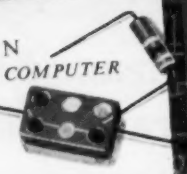

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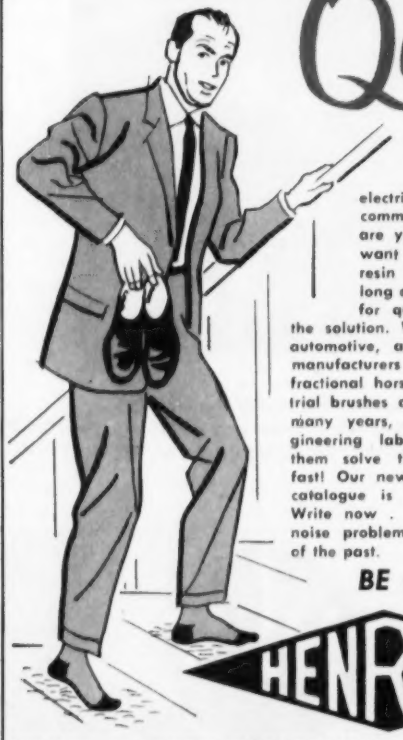


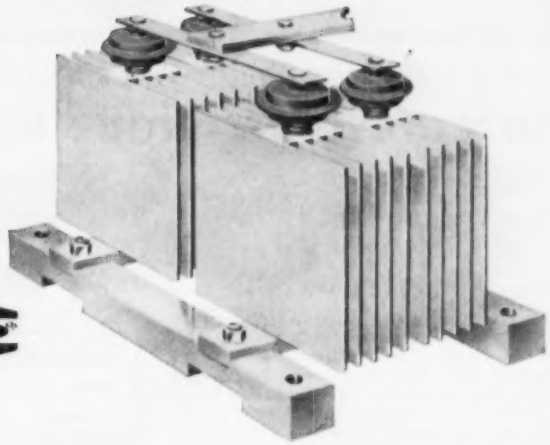
. . . WITH HENRITE CARBON AND GRAPHITE BRUSHES. If yours is the automotive or electrical field, and if poor commutation and noisy brushes are your big problem, you'll want to discover how Henrite resin bonded brushes . . . long accepted one of the best for quietness . . . can find the solution. We've supplied leading automotive, appliance and electrical manufacturers with automotive brushes, fractional horsepower brushes, industrial brushes and carbon resistors for many years, and our complete engineering laboratories have helped them solve their noise problems—fast! Our new, informative company catalogue is yours for the asking. Write now . . . find out how your noise problems can become a thing of the past.

BE RIGHT-WITH HENRITE

HENRITE PRODUCTS CORPORATION · IRONTON, OHIO

GENERAL ELECTRIC HIGH-CURRENT SILICON RECTIFIERS... NOW IN STACKS

Permits new highs in rectification efficiency with reduced space-weight-cost requirements



These new high-current rectifier stacks supply exceptionally long service without attention or maintenance. There are no moving parts, liquids, vapors, or sensitive electrodes involved. And the fin design provides adequate cooling in many applications without forced air.

The rectifying units proper are the famous 4JA60 Silicon high-current rectifiers produced by the General Electric alloy technique. Hermetically sealed in rugged metal housings, they are protected against damage from moisture, dust, fumes and corrosion.

Silicon high-current stacks are now available, completely assembled to meet your circuit requirements in stacks containing up to twelve rectifying elements. These compact, easily installed stacks may be the answer to your present design problems of big capacity in small space.

TYPICAL APPLICATION...GENERAL ELECTRIC 4JA6011 SILICON HIGH-CURRENT RECTIFIER STACK

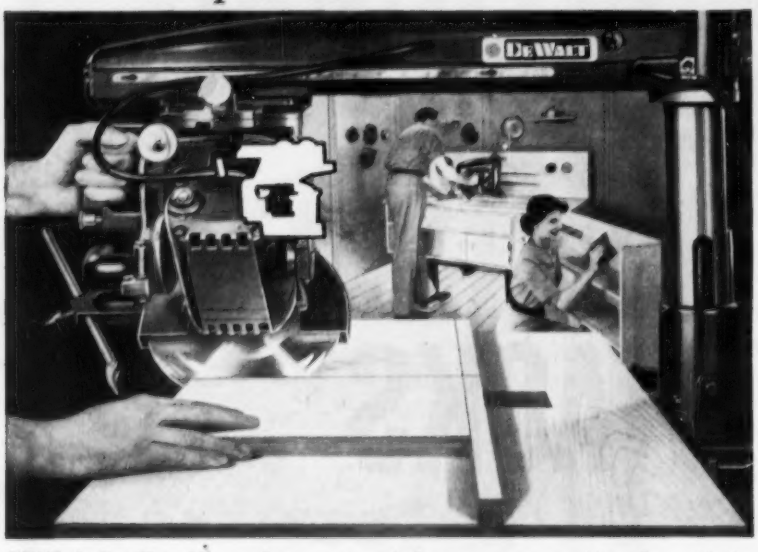
CIRCUIT	Three Phase Bridge Rectifier, Resistive Load.
DC OUTPUT	280 volts, 250 amperes, 70 kilowatts.
RECTIFIER LOSSES	Approximately one percent (¾ kw).
COOLING REQUIRED	35°C Free air. Forced air may be used for additional current if desired.
VOLUME	Total volume of assembly—less than ½ cubic foot.

Your General Electric representative will be glad to supply full data. Or, write to *General Electric Company, Semiconductor Products, Section S1837, Electronics Park, Syracuse, New York.*

Progress Is Our Most Important Product

GENERAL ELECTRIC

Potter & Brumfield *engineering is in this picture*

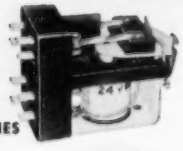


Which P&B relay would you specify for this

HIGH STARTING TORQUE MOTOR?

MP SERIES

MS SERIES


AB SERIES

Radial Saws by DeWalt, Inc. are used in thousands of home work shops, in lumber yards, carpenter shops and industry. The electric motors that operate these saws are a heavy duty single phase, AC, modern capacitor, voltage relay type. They have a ***high starting torque*** in order to quickly achieve operating speed, even when heavy line loads give lower voltage than normal. To avoid arcing and burning during initial current surge, DeWalt needed a positive, fast acting relay that would remain in contact until operating speed was reached.

Their choice? P&B MP series relays! These sturdy relays not only save arcing and burning during initial current surge, but are compact, rugged and dependable. Their versatility permits use with any capacitor type motor up to 2 horsepower. They can be furnished with an alnico magnet if whole snap action is needed.

This ready solution to DeWalt's relay problem is an example of how P&B relay engineering is daily adapting existing relay types to specific needs. P&B's unique 25 years of relay engineering experience provides an immense reservoir of skill, information and technical ability that can help solve your relay problems faster and more efficiently.

ENGINEERING DATA

SERIES: MP. Small general purpose power relay.
CONTACTS: ⅛" fine silver rated 25 amp., 115 V. AC non-inductive load, or 2 HP, 115 V. AC.
CONTACT ARRANGEMENTS: SPST NO, SPST NC, SPDT.
VOLTAGE RANGE: DC: Up to 220 V. AC: Up to 230 V.
COIL RESISTANCE: 15,000 ohm maximum.
TEMPERATURE RANGE: DC: —55° C. to +85°C. AC:—55°C. to +55°C.
TERMINALS: Standard pierced solder lug holes will take No. 10 hook-up wire.
ENCLOSURES: Dust cover, 2-59/64" L. x 2¼" W. x 2-3/32" H. Hermetically sealed cover dimensions same as above.
DIMENSIONS: Maximum 2¼" L. x 1¼" W. x 1⅞" H.
This relay will normally deliver a minimum of 300,000 operations before wear will warrant readjustment.

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC, ELECTRICAL, AND REFRIGERATOR DISTRIBUTORS

See our catalog in Sweet's Product Design File

Potter & Brumfield, inc.

PRINCETON, INDIANA *Subsidiary of* AMERICAN MACHINE & FOUNDRY COMPANY

Manufacturing Divisions also in Franklin, Ky. and Laconia, N. H.

(Continued from page 78A)

TRADE LITERATURE

Computer Bulletin. A 6-page illustrated bulletin describing the Bendix *G-15D* general-purpose digital computer and its digital differential analyzer accessory, is now available. The versatility and range of operations of the basic Bendix *G-15D* is considerably increased by the addition of this optional accessory. Linear and nonlinear differential equations are solved accurately and rapidly with the two units. New programming techniques and a complete new line of input and output equipment also are described. Copies will be mailed on request. Write Bendix Computer Division, Bendix Aviation Corporation, 5630 Arbor Vitae St., Los Angeles 45, Calif.

Plug-in Scaler-Counter. Using a pair of magnetic cores as count-determining elements, the Magnivider, recently introduced by Magnetics Research Co., White Plains, N. Y., features the high reliability inherent in magnetic devices. Compared to conventional four-tube counters, the one-tube Magnivider consumes 50% (per cent) less power and is one third the size. The scaler is designed for applications including frequency division, random counting, preset counting, accumulators, and television sweep synchronizing. Although no visual read-out is available, external circuits may be used to drive indicating devices. Complete information is available in the manufacturer's Technical Bulletin *145*.

Oil Tight Push Buttons. How to select the right push button for every application is the purpose of a 32-page catalog covering oil-tight and general-purpose push buttons, pilot lights, and accessories. The catalog includes a description of components and complete units, dimensions, cam action, and schematic diagrams. All types and styles are photographically illustrated. Write to Furnas Electric Company, 1063 W. McKee St., Batavia, Ill.

Molybdenum Disulfide Bulletin. A 2-page bulletin "Properties of Molybdenum Disulfide," has been issued by Climax Molybdenum Company, Dept. L, 500 Fifth Ave., New York 36, N. Y., and is available on request. Designated bulletin *Cdb-5* in the Climax chemical data series, the publication covers the physical properties, thermodynamic properties, electrical and magnetic properties, chemical properties, and preparation and uses of molybdenum disulfide (MoS_2). A blue-gray to black solid, molybdenum disulfide occurs naturally in molybdenum and copper ores, and can be prepared synthetically. The chemical and physical properties given in the bulletin are those reported for the natural material, which differs substantially in crystal structure from synthetic molybdenum disulfide. Uses of molybdenum as a lubricant additive and as a catalyst are discussed in detail in the bulletin.

(Continued on page 88A)

Another *NEW* Plug-In Unit

to *increase* the value of your Tektronix Type 541 and Type 545 Oscilloscopes

High Sensitivity for Fast-Rise Applications—The new Type 53/54L Fast-Rise High-Gain Preamplifier plugs into your Type 541 and Type 545 Oscilloscopes, increasing the calibrated vertical deflection factor to 5 millivolts/cm. At the higher deflection factors (5 millivolts/cm to 50 millivolts/cm), risetime is 0.015 μsec and vertical passband is 3 cycles to 24 mc. From 50 millivolts/cm to 50 volts/cm characteristics are the same as the Type 53/54K Unit . . . risetime 0.012 μsec, passband dc to 30 mc. Input capacitance is 20 μμf direct, 8 μμf with the 10x attenuator probe furnished with Type 541 and Type 545 Oscilloscopes. Other probes with higher attenuation ratios are available to reduce input capacitance to as little as 2.5 μμf.

Type 53/54L Fast-Rise High-Gain Unit $185

First shipments are expected to be made during July, 1957. Please keep in touch with your Tektronix Field Engineer or Representative for current details.

OTHER PLUG-IN UNITS FOR TYPE 530-SERIES and TYPE 540-SERIES OSCILLOSCOPES

Type 53/54A—Wide-Band DC Unit	$ 85
Type 53/54B—Wide-Band High-Gain Unit	125
Type 53/54C—Fast-Rise Dual-Trace DC Unit	275
Type 53/54D—Differential High-Gain DC Unit	145
Type 53/54E—Low-Level Differential AC Unit	165
Type 53/54G—Differential Wide-Band DC Unit	175
Type 53/54K—Fast-Rise DC Unit	125

Prices f.o.b. Portland, Oregon

SEE THE TYPE 53/54L UNIT AND OTHER NEW TEKTRONIX INSTRUMENTS AT THE IRE SHOW, BOOTHS 3028, 3029 AND 3030.

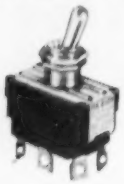
Tektronix, Inc.

P. O. Box 831 • Portland 7, Oregon
Phone CYpress 2-2611 • TWX-PD 265 • Cable: TEKTRONIX

APPLIANCE SWITCHES

10 Amp. 250 V. A-C
15 Amp. 125 V. A-C [L]
¾ H.P.-120-240 V. A-C

L-52-P



D.P.D.T. • on-off-on • Solder Lugs

10 Amp. 250 V. A-C
15 Amp. 125 V. A-C [L]
¾ H.P.-120-240 V. A-C

L-50-N

D.P.D.T. • on-on • Screw Terminals

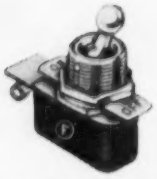
15 A—125 V. A-C
10 A—250 V. A-C
¾ H.P.-120 Volts A-C
1 ½ H.P.-240 Volts A-C

2230

S.P.S.T. • on-off • Screw Terminals

3 A—125 V. [T]
6 A—125 V.
3 A—250 V.

1887-LP



S.P.S.T. • on-off • Solder Lugs

10 Amp. 250 V. A-C
15 Amp. 125 V. A-C [L]
¾ H.P.-120-240 V. A-C

L-42-E

S.P.D.T. • on-off-on • Solder Lugs

10 Amp. 250 V. A-C
15 Amp. 125 V. A-C [L]
¾ H.P.-120-240 V. A-C

L-40-A

S.P.S.T. • on-off • Screw Terminals

⅛ Amp. 125 V. D-C
3 Amp. 125 V. A-C
6 Amp. 24 V. D-C

K-10-A

S.P.S.T. • on-off • Screw Terminals

10 Amp. 24 V. D-C
3 Amp. 125 V. A-C

L-20-E

S.P.D.T. • on-off-on • Screw Terminals

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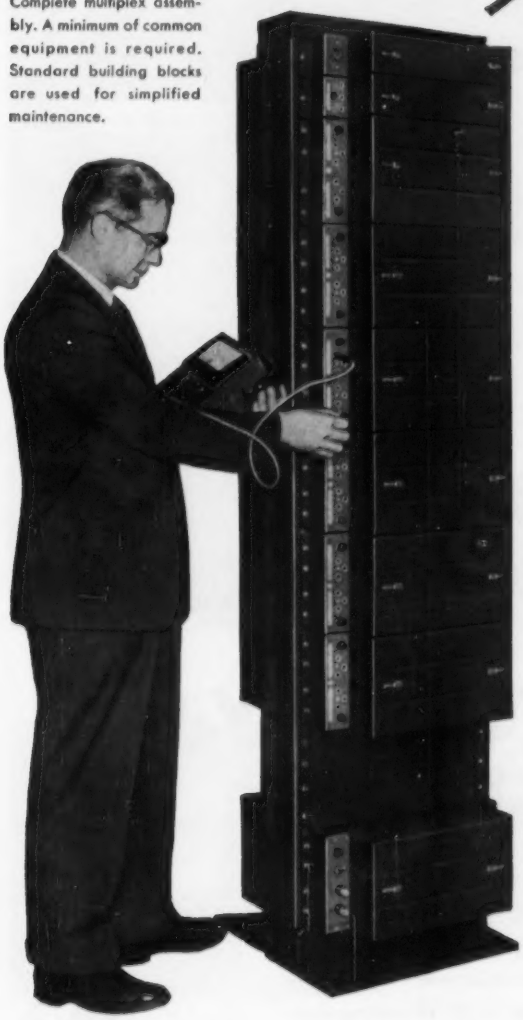
NOW... Big News in Microwave Multiplex Channeling Equipment!

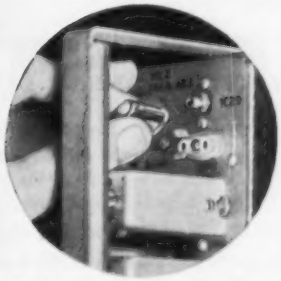
Complete multiplex assembly. A minimum of common equipment is required. Standard building blocks are used for simplified maintenance.



New RCA Type MV-124 with All Channel Units Identical and Interchangeable

Specifically designed for microwave use and thoroughly field tested, this new RCA Channeling Equipment provides complete flexibility. Frequency selection is by means of a plug-in crystal. Except for this crystal, *all Channel Units are identical and interchangeable*, thus simplifying planning, installation and maintenance.

Whatever your channeling requirements, these famous quality Channel Units can be easily stacked to provide two channels, three channels, or up to 24 voice channels without group modulating. High capacity systems can be obtained by stacking 24 channel groups. One unit is required for each voice channel desired. Single sideband suppressed carrier techniques are used to supply 24 channels in the band between 10 kc and 130 kc frequency, leaving frequency space for 18 tone channels below 10 kc. Simultaneous transmission of many channels of intelligence is accomplished by modulating separate sub-carriers spaced uniformly throughout the base-band modulating system. Channels are spaced one above the other in the available modulating band width.



To change channel assignment, simply change one plug-in crystal.

CRYSTAL CONTROL assures high stability and greater accuracy. For operations such as frequency shift telegraph and facsimile transmissions, an unusually high degree of clarity is attained.

DOUBLE HETERODYNING enables all circuits in all units to be identical except for the plug-in crystal element.

SINGLE SIDEBAND OPERATION enables each channel to use a minimum of spectrum space. This means less obsolescence due to possible congestion of the available microwave spectrum.

RCA Microwave . . . performance-proved in more than a million channel miles of operating systems throughout the world.

RCA Microwave Specialists will be glad to answer any questions and help plan your installation. Nation-wide services of the RCA Service Company are provided to keep entire system operating at its peak. Mail coupon for further particulars.

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COMMUNICATIONS PRODUCTS
Camden, N. J.

Radio Corporation of America
Communications Products, Dept. P-42, Building 15-1, Camden, N. J.

Please send me the latest literature on:

- ☐ RCA Multiplex Channeling Equipment
- ☐ RCA Microwave for use in .....

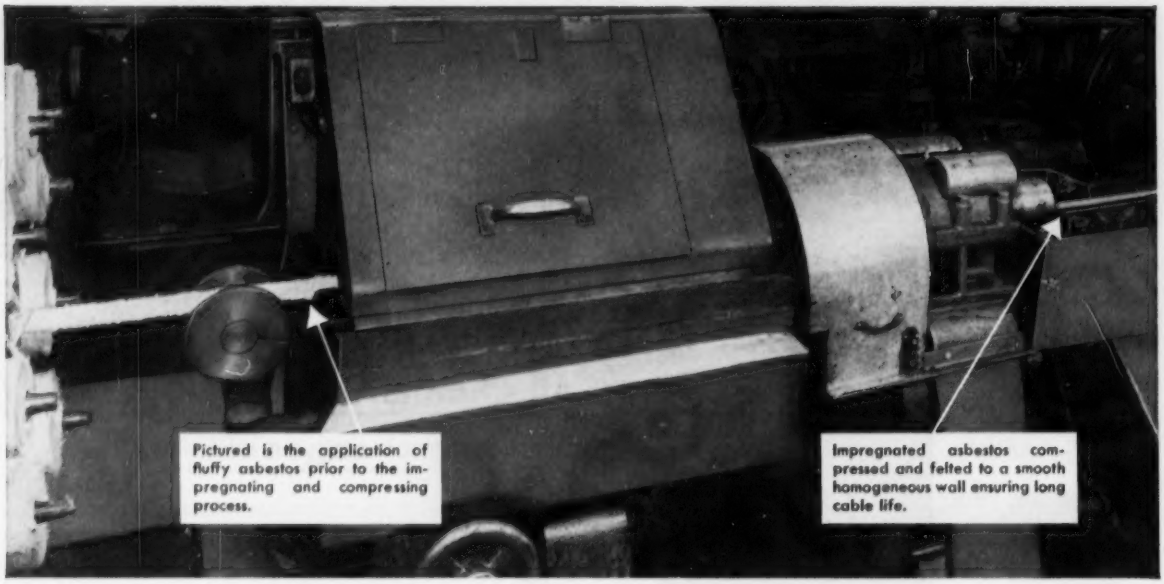
Name ..... Title .....

Company .....

Address .....

City ..... Zone ..... State .....

☐ Have representative contact me.


Pictured is the application of fluffy asbestos prior to the impregnating and compressing process.
Impregnated asbestos compressed and felted to a smooth homogeneous wall ensuring long cable life.

Felted Asbestos Walls + Impregnation with Selected Compounds + Quality Varnished Cambric Tapes . . .

That's the Backbone of

ROCKBESTOS A.V.C.® (N.E.C. TYPE AVA) QUALITY

Different brands of N.E.C. Type AVA wire and cable may look alike on the surface but the sure proof of quality that means dependable service is beneath the braid.

In the Rockbestos A.V.C. construction dense, felted, thoroughly impregnated asbestos walls seal the varnished cambric tapes away from air and moisture.

The varnished cambric tapes are made to Rockbestos exacting specifications and are applied under controlled methods assuring uniform dielectric strength.

The result . . . you get long life and dependable service under every type of operating conditions . . . in temperatures up to 230°F.

Complete construction and test specifications of Rockbestos A.V.C. are in the new booklet: "Specifications RSS-88". Write for your copy.

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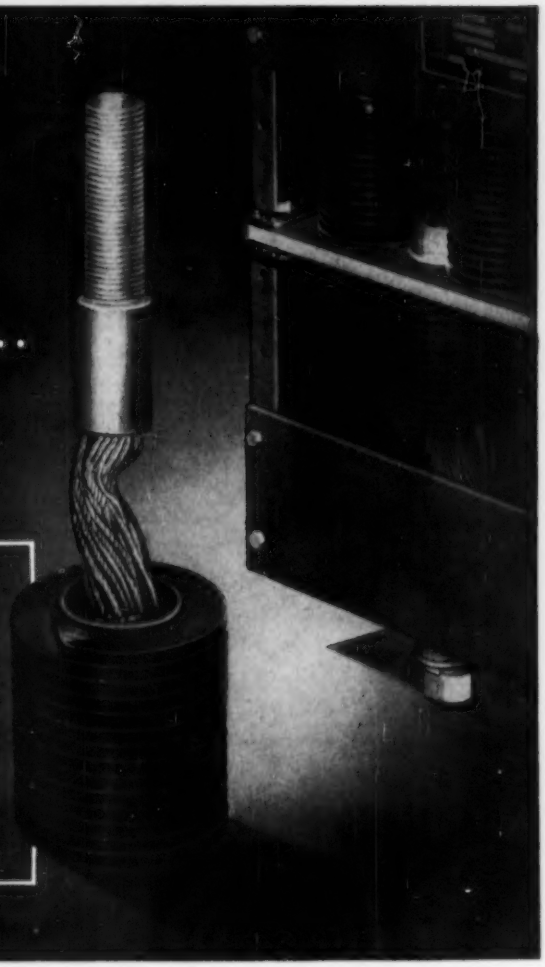
STOCKED COAST TO COAST
Standard Rockbestos A.V.C. construction (N.E.C. types AVA, AVB, etc.) are available for immediate shipment. Call or write nearest branch office.

Another engineering FIRST... by International!



This thermodynamic design—developed in International's Research Laboratories—sets new standards for heat dissipation in Germanium Power Rectifier Junctions.

International offers a complete line of Germanium Power Rectifiers. For complete details on all types, request Bulletin GPR-1.

Finned copper housings—the most efficient heat exchangers yet adapted to power rectifiers—measuring less than 2" in diameter, provide a total cooling surface of 58.3 sq. inches! International's Style F Germanium Power Rectifier utilizes this junction, which has been acclaimed by leaders in the engineering profession as the most advanced rectifier design in the industry.

International's Research Laboratories and Production Facilities have produced a line of Germanium Power Rectifiers offering unexcelled performance. Four years of field testing indicate efficiency up to 97%, with unlimited life expectancy. 12,000-hour tests show no change in forward or reverse resistance. Extremely low leakage current and low forward drop (lowest of all available metallic rectifiers) emphasize the advantages of these units. D.C. output current ranges up to 2250 amps per assembly, and up to 100,000 amps in combination. The input voltage ranges up to 66 volts rms per junction, with an operation temperature range from −55° C to +75° C.

The far-reaching research and development program of International assures you of greater rectification efficiency and reliability. A wire, letter or phone call to Application Advisory Department will bring an immediate and experienced recommendation for your application.

A WORLD OF DIFFERENCE ...THROUGH RESEARCH

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CORPORATION

EXECUTIVE OFFICES: EL SEGUNDO, CALIFORNIA · PHONE OREGON 8-6281

NEW YORK: 132 E. 70TH ST., TRAFALGAR 9-3330 · CHICAGO: 205 W. WACKER DR., FRANKLIN 2-1889
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CONCRETE REINFORCING STEEL INSTITUTE
C.R.S.I.
AISC
for over 40 years
FLINT STEEL CORPORATION
TULSA . . . MEMPHIS

(Continued from page 82A)

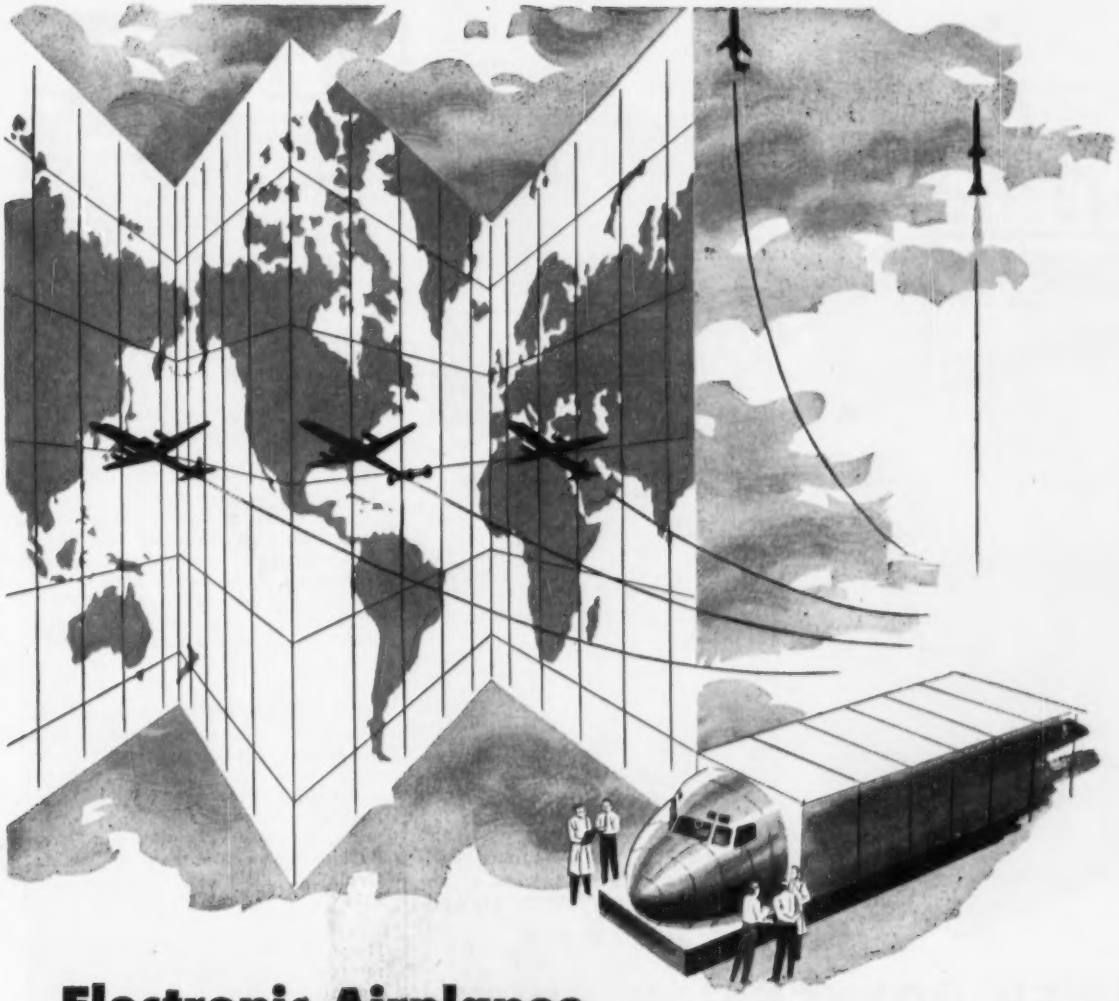
Trade Literature

Accident Prevention Program. "Safety Is Our Business" is a new manual of safe practices for truck operators. Published by the White Motor Company's Service Division after two years of safety research in the trucking industry, the manual directs latest information on safe practices to operators, drivers, and mechanics. It emphasizes the importance of preventive safety maintenance and features a series of bulletins to be issued at regular intervals calling attention to various safety developments. For full details, ask your White representative or write to Service Safety Division, The White Motor Company, Cleveland 1, Ohio.

Movie on Insulating Tape. A new 20-minute color movie, "All Holes Barred," showing the correct application of "Scotchrap" vinyl pipe insulating tape for corrosion prevention has been announced by Minnesota Mining and Manufacturing Co., (3M), Dept. *D7-2*, 900 Fauquier St., St. Paul 6, Minn. Prepared as a training film for free showing to workmen using vinyl pipe insulating tape, the film is available through 3M branch offices and salesmen. The color and sound movie presents corrosion principles in a very elementary manner with cartoon characters dramatizing the effect of electrolysis on unprotected and improperly protected pipe. Step-by-step sequences show proved methods of insulating couplings, street T fittings, weld joints and elbows, as well as straight sections of pipe. The use of taping machines and short-cuts for hand wrapping tape are also illustrated and explained in the movie narration.

System Test Brochure. A 22-page brochure, "Systems Evaluation Test Equipment," *LP-3528*, which explains the philosophy of system test equipment for military electronic systems has been made available by Link Aviation, Inc. This illustrated booklet presents complete application information and design concepts of specific GO–NO–GO testing devices which the company has custom built for use in conjunction with an existing analog bombing system. The brochure describes typical applications of systems evaluation test equipment for testing complete systems and checking components within a system. It also discusses the economic advantages of this advanced approach to electronic testing. Copies of the brochure, *LP-3528*, may be obtained from the Industrial Sales Department, Link Aviation, Inc., Binghamton, N. Y.

Template-Ruler. This ruler permits faster and more accurate drawings of the "QUAD RING" seal manufactured by Minnesota Rubber & Gasket Company, 3628 Woodale Ave., Minneapolis 16, Minn. The ruler will be given to all design engineers whose companies are now using or intend to utilize the new four-lipped ring in various sealing applications. Rule sections of the 6 inch template-ruler are marked off in eighths- and sixteenths-of-an-inch divisions.



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that check out any crew, any aircraft or design . . . for any mission or air route in the world

Throughout the world, flights in electronic Simulators —which never leave the ground—enable crews who will soon command undelivered aircraft to fly them in advance electronically . . . guide them over specified courses through precision instrumentation . . . land them on strange airports . . . readying for the day when they will fly the actual aircraft.

The Simulator provides the exact "feel" of the prototype. Instruments, navigation, sounds, operational problems—all are simulated with complete realism. Months of experience are compressed into hours.

Electronic Simulators built by Curtiss-Wright for every aircraft type—including the new jets—are adding to the safety of flight, saving millions of dollars and thousands of manhours yearly for commercial and military operators all over the world.

ELECTRONICS DIVISION

Simulators by **CURTISS-WRIGHT** CW

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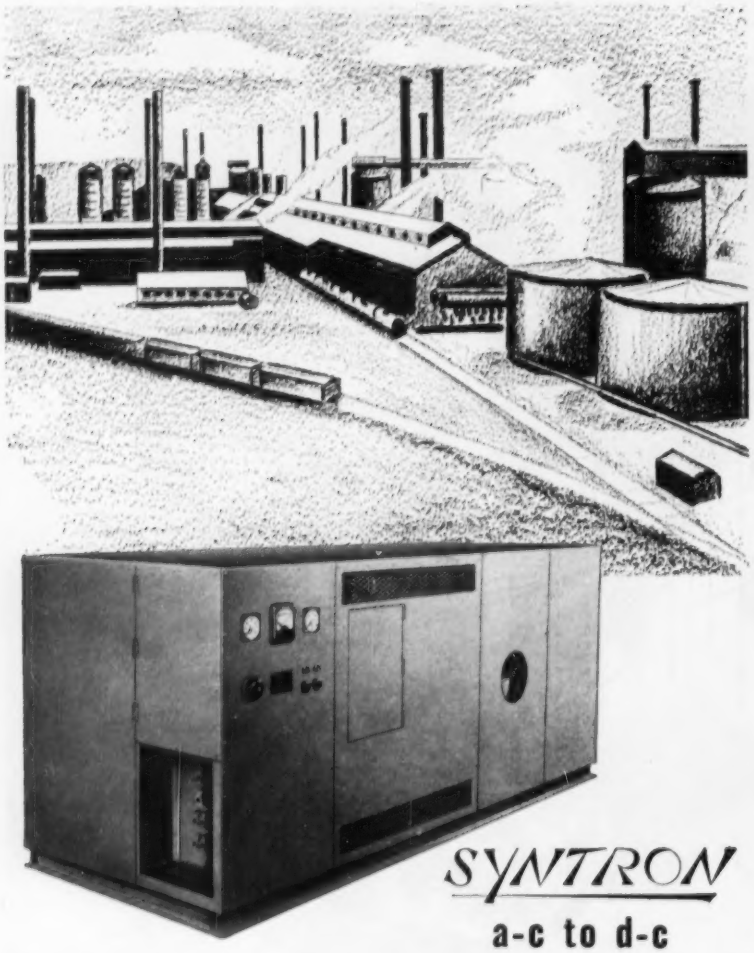


POWER CONVERSION UNITS

Provide complete automatic, low cost, a-c to d-c power conversion in one single package. SYNTRON Power Conversion Units contain heavy duty Selenium Rectifiers, automatic voltage regulation. They require no warm up time. SYNTRON POWER CONVERSION UNITS have a high overload capacity, able to withstand high overloads for short, infrequent periods without damage. All units are designed to meet the rigid requirements of the Mining Industry—rated for continuous operation. SYNTRON Power Conversion Units have a proven record in the Mining Field, a record of dependability, high efficiency long life and low cost, simple maintenance. They are compact, easy to install, can be located on any flat surface. They save valuable space. Let Syntron solve your Power Conversion problems.

Write for complete Catalogue Data—FREE

SYNTRON COMPANY
440 Lexington Avenue Homer City, Penna.

(Continued from page 88A)

Trade Literature

Rate Analyses. Population and industrial shifts are creating a number of problems for utility companies. One of these is keeping records of rate structures. A booklet describing a method of producing rate analyses has been put out by the Recording & Statistical Corporation, 100 Sixth Ave., New York 13, N. Y. This booklet should be of interest to rate engineers and management men. Write to the company for a free copy.

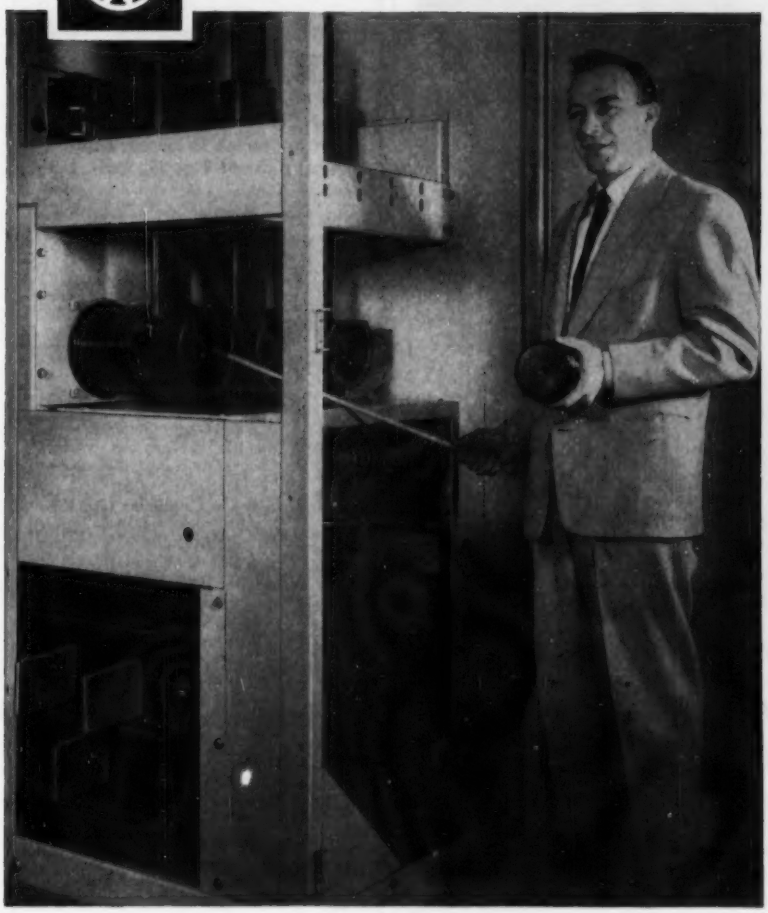
Film on Seaway. The dramatic story of the planning and development of the huge St. Lawrence Seaway, a project rivaling that of the Suez Canal or Panama Canal, is told in straightforward documentary style in a new color and sound film, "The Eighth Sea," presented by Caterpillar Tractor Co. Walter Cronkite, popular United States television commentator, narrates the film, giving each detail of the giant undertaking in a factual and logical explanation. "The Eighth Sea" is available for use through the nearest Caterpillar dealer or by writing the Advertising Division of Caterpillar Tractor Co., Peoria, Illinois.

Autotransformer Bulletin. A 24-page bulletin describes the complete line of Variac (registered trade mark) adjustable autotransformers. Dimension drawings, in addition to photographs, are included for all models, and complete specifications and prices are tabulated. Write to the General Radio Company, 275 Massachusetts Ave., Cambridge 39, Mass., requesting bulletin *O*.

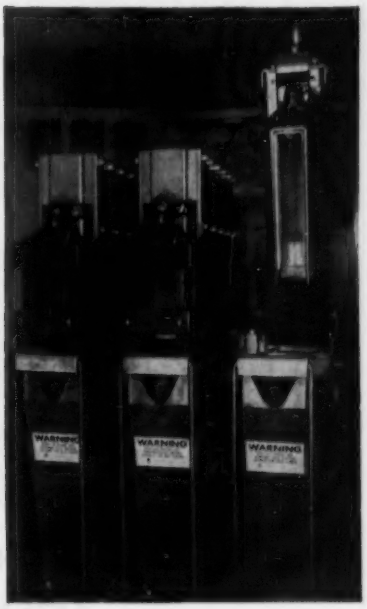
Home Intercom. Communication between rooms as well as between master and remote stations has been made available for the first time in a new home intercom system by the Mark Simpson Mfg. Co., Inc., 32-28 49th St., Long Island City, N. Y. An important feature of the Masco Multi-Talk Intercom System is that music can be distributed to selected points in the system by plugging in any radio, phonograph, recorder, or record changer. A flush-mount radio or a portable radio can be installed as additional equipment if desired.

Epoxy Resin Chart. A summary chart, outlining the physical and electrical properties of epoxy resin systems available from the Permacel Tape Corporation can be obtained from the company upon request. The chart lists 25 different systems handled by the company and the basic properties of each. Information on the chart includes such things as the average pot life of the resin in a 100-gm mass at +80 F, viscosity in centipoises at —80 F before and after addition of hardener, physical properties of cured samples at +80 to 85 F, volume resistivity, dielectric constant, and dissipation factor. Copies of the chart may be obtained by writing to Department ER, Permacel Tape Corporation, New Brunswick, N. J.

METAL-CLAD SWITCHGEAR



PURIFIED PORCELAIN in horizontal and vertical bus supports, primary disconnect bushings and caps and epoxy in bus joint covers provide excellent insulation, prevent fires in 15 kv I-T-E metal-clad switchgear.



EPOXY AND SPECIAL CERAMICS protect personnel and equipment by preventing fires in the circuit breaker section. Arc chute rear supports and blowout coils are epoxy. Jump gap cooling plates, arc chute liner plates, arc plates and spacers are special ceramics.

Only the finest fire-protective insulating materials

Nonflammable porcelain and ceramics, flame-resistant epoxy, and other flame-retardant insulating materials throughout, are among the extra values you find in I-T-E Metal-Clad Switchgear. Purified porcelain, of which the primary disconnect bushings and caps are made, also supports both vertical and horizontal bus. It is nonflammable, has high dielectric strength, won't track or deteriorate, is inherently contamination free.

Epoxy, which can be molded into complicated shapes, forms arc chute rear supports, blowout coils, bus joint covers, potential and current transformers. It has high mechanical and dielectric strength, is nontracking and extremely flame resistant.

Special ceramics, highly resistant to direct arc exposure, are used in jump gap cooling plates, arc chute liner plates, arc plates and spacers. These have high dielectric strength, low moisture absorption, won't track, are excellent interrupting materials. They do not deteriorate when subjected to direct arc exposure. They absorb thermal shock and deionize gases without excessive heating.

Phenolic and polyester insulating sheets and moldings, specially treated to provide the highest possible degree of flame-retardant characteristics, are also used.

If you are planning new construction or modernization requiring electric power, consider the advantages of I-T-E equipment. Consult your local I-T-E sales office or write I-T-E Circuit Breaker Company, 19th & Hamilton Sts., Philadelphia 30, Pa.

I-T-E CIRCUIT BREAKER COMPANY • Switchgear Division

IN CANADA: EASTERN POWER DEVICES, LTD.

BIDDLE *Instrument News*

FRAHM® FREQUENCY MONITOR

. . . for opening or closing an electrical contact when the frequency of the power line to which the monitor is connected reaches a preset limit. The monitor can be furnished for low or for high limit operation.

TYPICAL APPLICATIONS

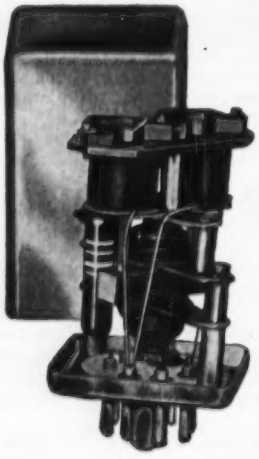
. . . In power transmission systems as a low frequency alarm with manual reset to call for load shedding or other corrective action to bring system frequency back to normal.

. . . For generators as low and high frequency alarm and, under certain conditions, as simple "on-off" frequency controller which can keep frequency between preset low and high limit.

. . . For turbines and other machinery with parts rotating at high speed as overspeed alarm and limiter when used in conjunction with an electric tachometer generator.

Write for **PRICES** and **BULLETIN 33-06-EE**

FRAHM® RESONANT REED OSCILLATOR CONTROLS



These electro-mechanical components are used in electronic oscillator circuits to stabilize the oscillation frequency within close limits.

Oscillator controls can be made for any frequency within the range of 50 to 1100 cps.

TYPICAL APPLICATIONS

Electrical and Acoustical Measurements; Communication; Remote Operation and Supervisory Control; Electrical Computing; Telemetering.

FEATURES

High accuracy and stability of oscillating frequency • Self starting operation • Full interchangeability of oscillator controls with different nominal frequency in the preferred circuits • Infinite operating life of the reeds • Integral unit sealed, magnetically shielded and of very rugged construction • Light weight and small • Can be furnished to meet certain military specifications for electronic circuit components.

Write for **PRICES** and **BULLETIN 34-EE**

FRAHM® RESONANT REED FREQUENCY SENSITIVE RELAYS for use as frequency selective elements in the receiving systems are described in **BULLETIN 33-EE.**

8611

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• SPEED MEASURING INSTRUMENTS
• LABORATORY & SCIENTIFIC EQUIPMENT

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AIEE REPORTS

These publications are proposals for new standards or test codes, or revisions of present publications, which are in the formative stage. They are made available without cost, so that all interested individuals may obtain them for study and comment, thus supplying practical experience in their use before submission for adoption.

1A General Principles for Rating of Electric Apparatus for Short-Time Intermittent or Varying Duty (September 1941)

1 Addendum to AIEE No. 1 General Principles Upon Which Temperature Limits Are Based in the Rating of Electric Machines and Other Equipment (February 1956)

52 Application Guide for Grounding of Instrument Transformer Secondary Circuits and Cases (March 1951)

56 Insulation Maintenance Guide for Large AC Rotating Machinery (May 1954)

57 Test Procedure for Evaluation of the Thermal Stability of Enamelled Wire (October 1955)

58 Induction Motor Letter Symbols (January 1956)

59 Test Code for Metallic Rectifiers (March 1956)

450 Guide for Specification of Electronic Voltmeters (April 1955)

451 Guide for Specification of Signal Sources (April 1955)

452 Guide for Specification of Cathode-Ray Instruments (April 1955)

504 Test Code for Carbon Brushes (October 1953)

505 Test Code for Power Factor Testing of Power Transformers (January 1955)

506 Test Code for Power Factor Testing of Distribution Transformers (October 1955)

802 Test Code for Direct-Current Carbon-Pile Voltage Regulators for Aircraft (April 1955)

954 Application Guides for: Ground-Fault Neutralizers; Grounding of Synchronous Generator Systems; and Neutral Grounding of Transmission Systems (October 1954)

955 Guide for Evaluating the Effect of Solar Radiation on Outdoor Metal-Clad Switchgear (October 1955)

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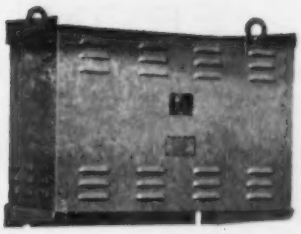

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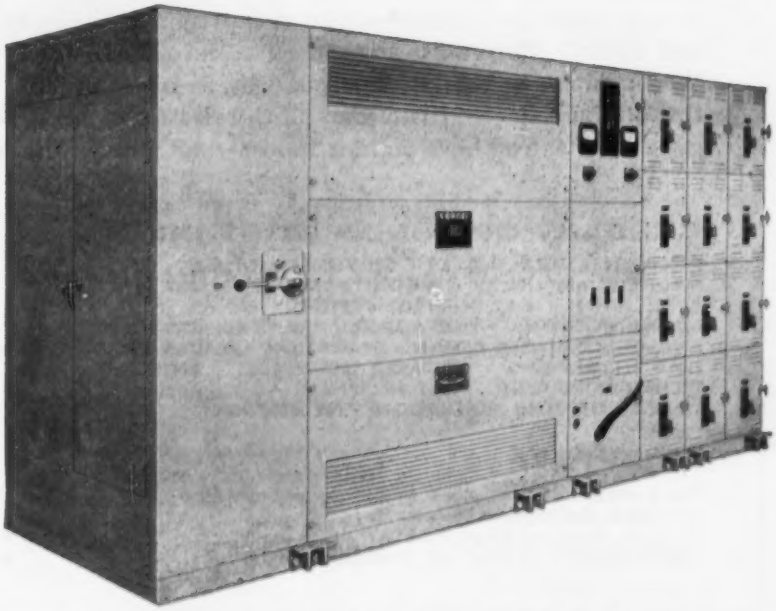

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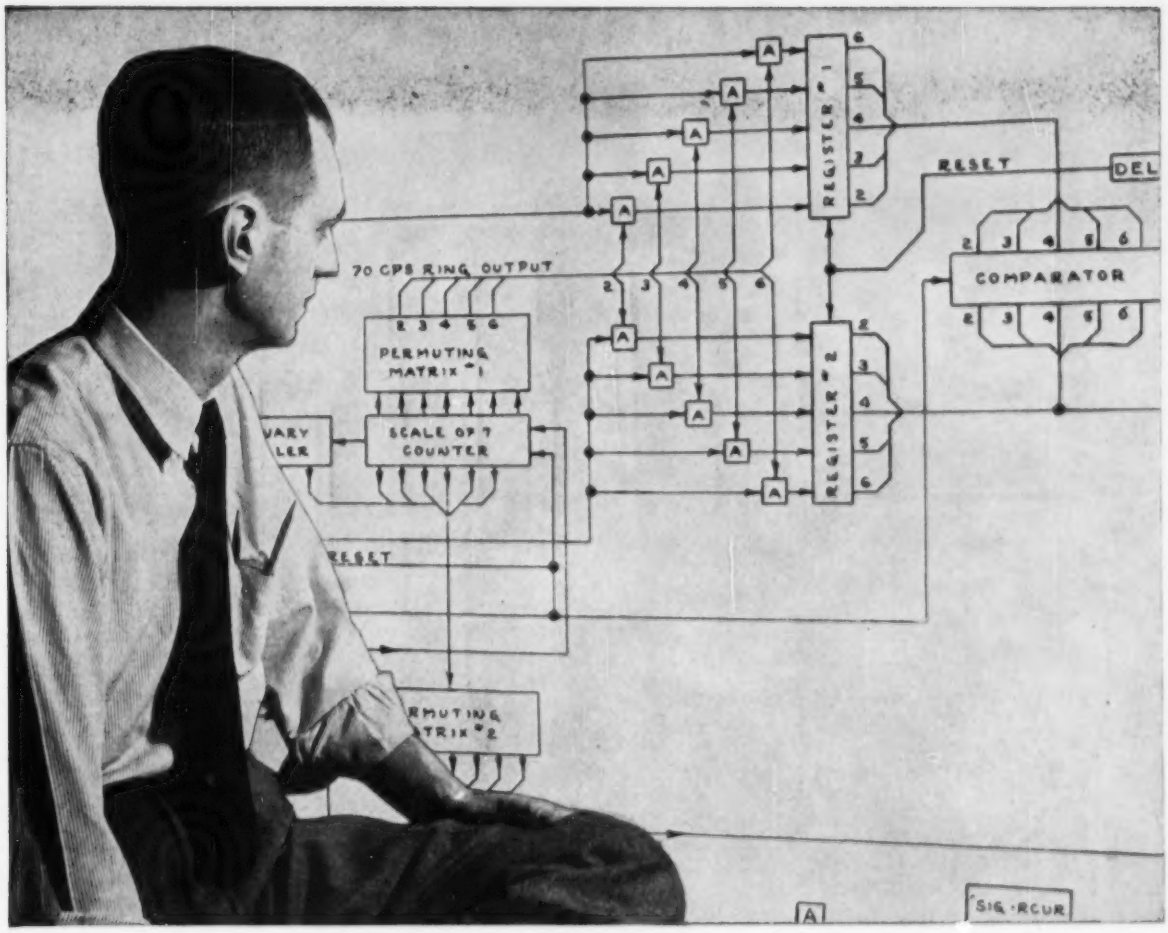

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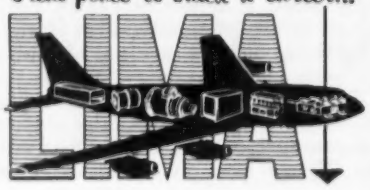

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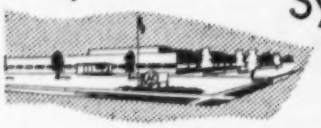

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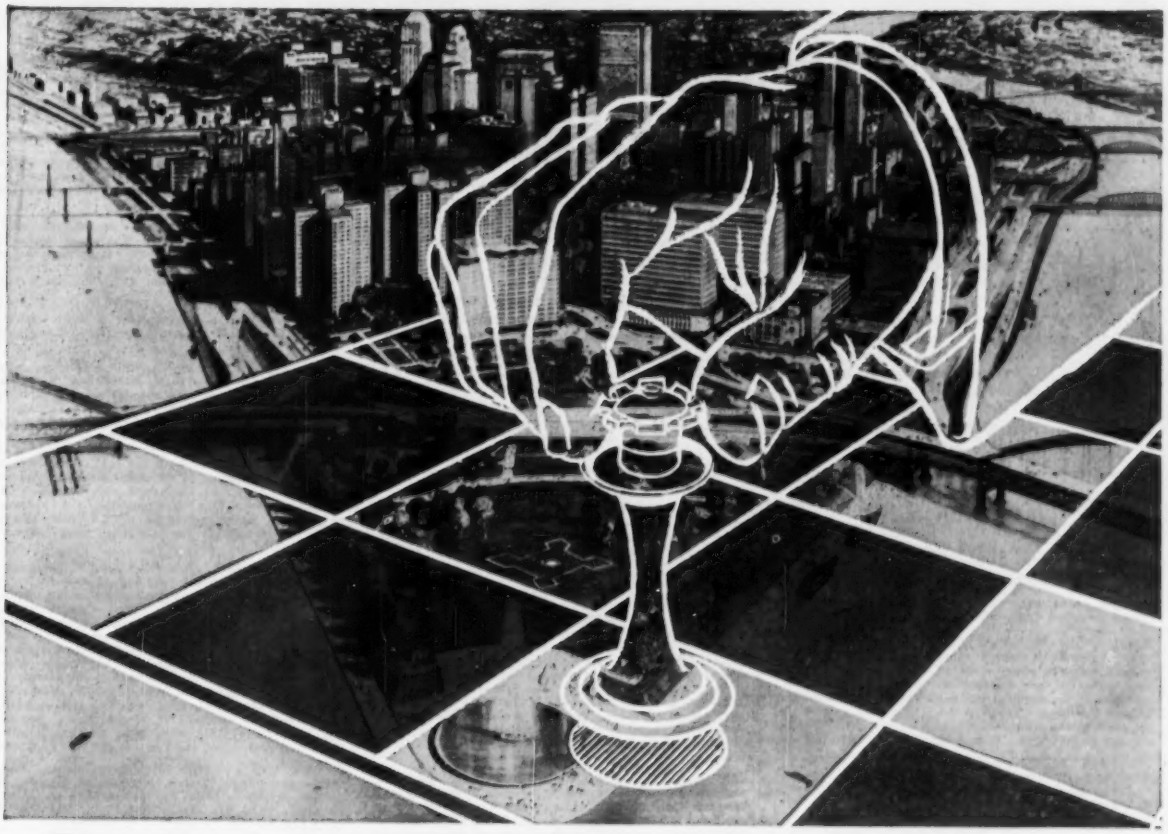

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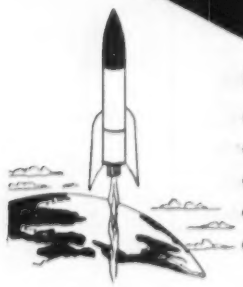

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(Continued from page 108A)

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(Continued from page 106A)

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(Continued on page 113A)

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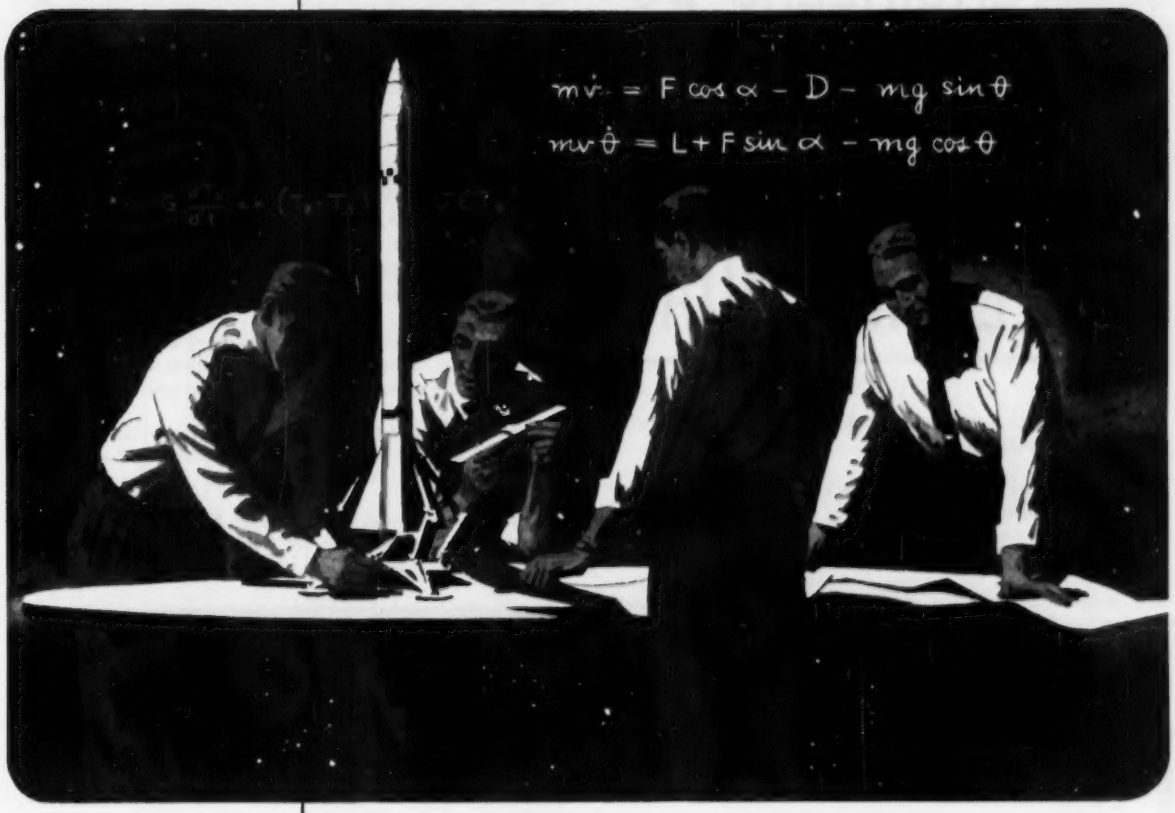

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And the location on the Connecticut shore provides a relaxed way of life, with hunting, fishing, sailing, skiing—all manner of recreational activities for the entire family.

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DAN E. FOSTER
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(Continued from page 108A)

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Positions Wanted

ELECTRICAL ENGINEER—M.Sc. from Poland, educated in Britain, 8 years of insulation testing and research, laboratory HV and field experience, several publications, built dielectric measuring instruments, will consider any electrical engineering engagement in USA or overseas. Box 525.

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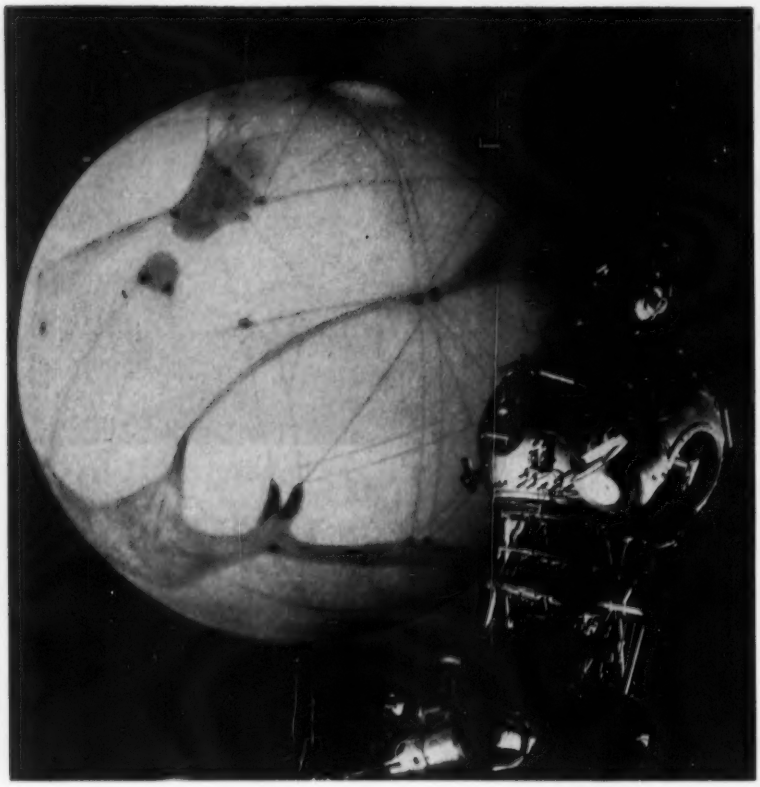

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ELECTRONICS DIV.,
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Zenith Radio Corporation has important openings for electrical and mechanical engineers with a talent or interest in: Black and White and Color Television, AM/FM Receivers —Transistor Circuitry—Electro-Acoustics and Special Products — Hearing Aid Design and Circuitry.

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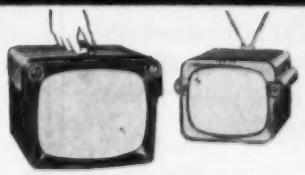

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ENGINEER, EE or PHYSICS MAJOR

ACOUSTICAL ENGINEER familiar with LOUDSPEAKER DESIGN AND APPLICATION

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Citizenship Not Required

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Rapid expansion makes this position particularly inviting to a man of ability, where advancement and promotion are important factors.

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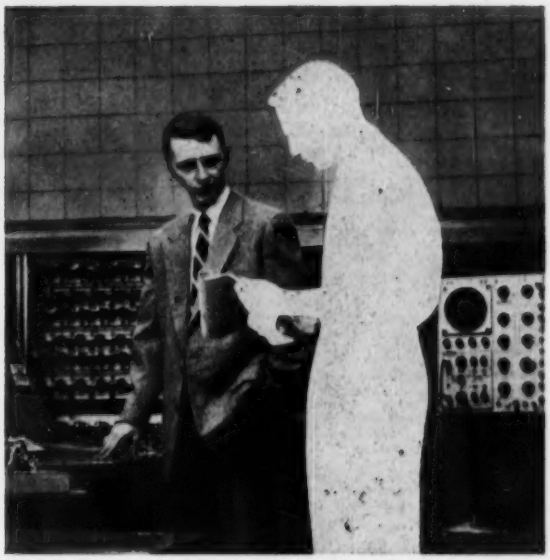
RADIO RECEIVER DEPARTMENT
GENERAL ELECTRIC
869 Broad Street, Utica, N. Y.

IBM GROWTH promoted these men

PRODUCT DEVELOPMENT ENGINEER: Before his recent promotion, this man was a member of a small engineering "team" (two M.E.'s, an E.E. and a model maker) in IBM's Poughkeepsie plant. His specific project entailed the creation of the "ultimate package in printed circuitry." His group "brainstormed" the project in continual sessions, putting the results in model form. Then the group would try to "tear the idea to shreds" in order to create something even better.



PRODUCT CONTROL ENGINEER: Promoted recently, this man formerly worked at IBM's Poughkeepsie manufacturing facilities. His job was to design information systems to insure a smooth flow of work through the plant. "It takes *creative* engineering ability to design these systems," he'll tell you, "and *administrative* ability to 'sell' a system to higher management and make it stick. If you possess this rare combination of abilities, this is the job for you!"

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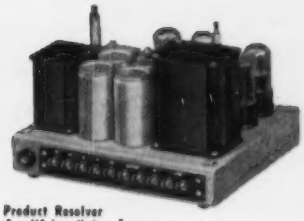

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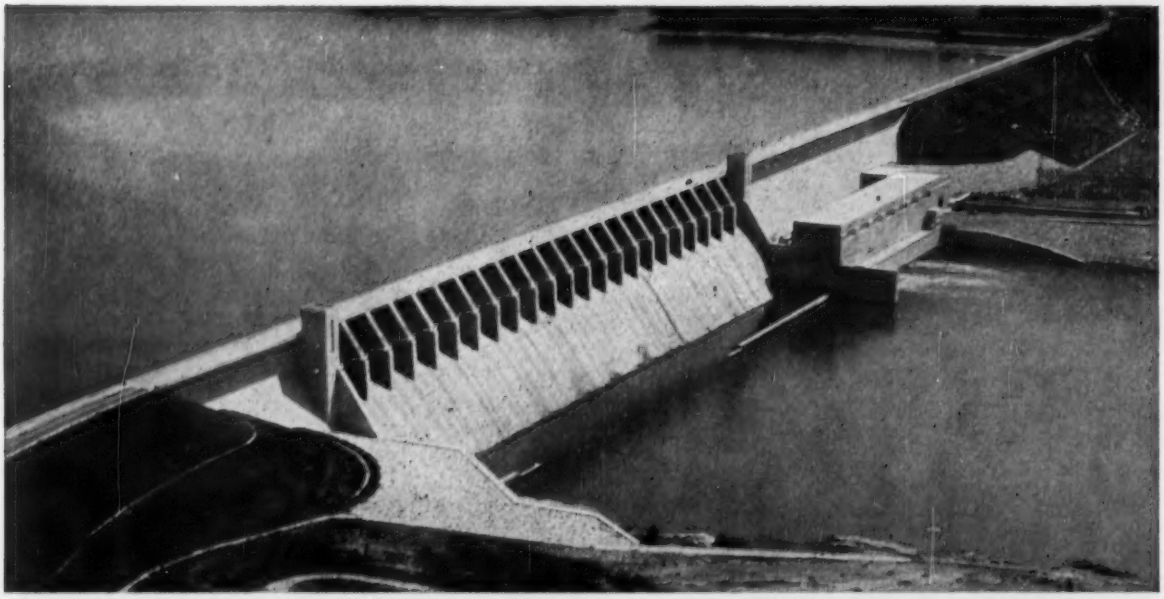
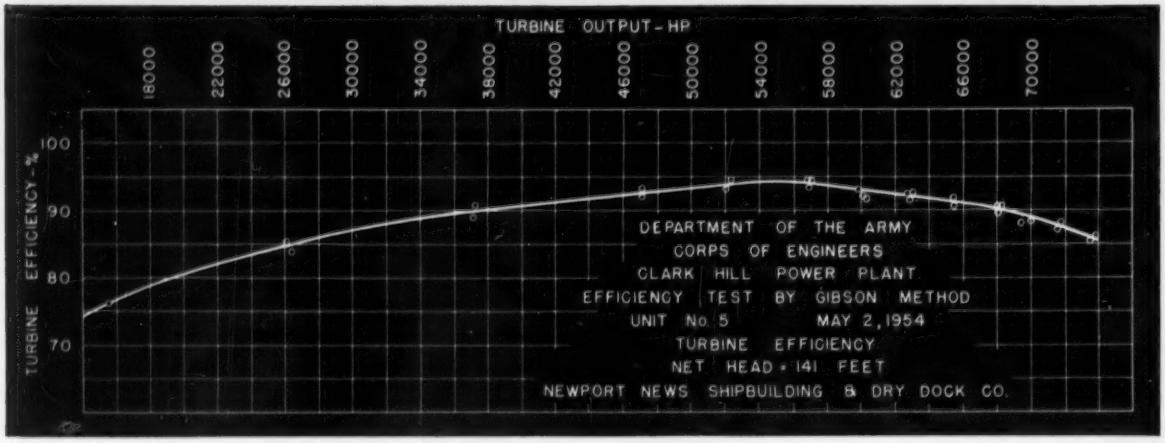
This Weston Product Resolver employs an electronically balanced electrodynamometer instrument mechanism to develop a product output signal from two input signals by torque multiplication. The Inductronic® balancing system provides precise and rapid response, and an exceptional order of response to displacement. The mechanism is unique to this purpose and stems from Weston's long experience in the design and manufacture of precision dynamometer mechanisms. The complete story on the Model 1482 Inductronic Product Resolver can be obtained from your local representative or by writing Weston Electrical Instrument Corp., Newark 12, N. J., A subsidiary of Daystrom, Inc.





Maximum efficiency of 94.1%

Reflects advanced practices at Newport News

THE GRAPH shows performance of a 55,000 horsepower turbine, one of seven such units built by Newport News for the Clark Hill Power Plant (see photo).

Shape of the curve is typical . . . not exceptional . . . for Newport News turbine performance. Regular, uniform, showing no-cut-off at full load, it indicates consistent delivery and stable operation.

And especially, experience in design and model testing.

At Newport News, turbine runners are continually being designed and redesigned for improvements in performance. And often upon receiving a contract for turbines, a model setting is built and complete tests made. So far, Newport News has filled turbine contracts with an aggregate rated output in excess of 7,000,000 horsepower.

Penstocks, spiral casings, valves, pumps, rack rakes and other essentials are also designed and built by Newport News. Our illustrated booklet, "WATER POWER EQUIPMENT," will be sent to you upon request.

Engineers . . . Desirable positions available at Newport News for Designers and Engineers in many categories. Address inquiries to Employment Manager.

Newport News

Shipbuilding and Dry Dock Company
Newport News, Virginia

Another New Variac

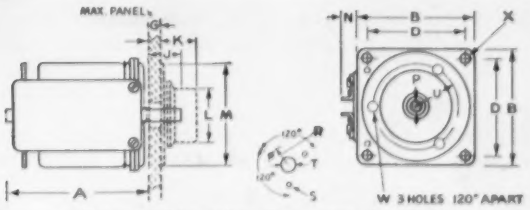
Just a Handful but it Handles over 1¼ kva!

In many applications the over-voltage output feature of VARIACS is not required. When the output voltage of a VARIAC, operating on 60 cycles, need be varied only from zero to a maximum equal to the line voltage, modifications of the standard VARIAC can increase its power-handling capacity materially.

This is the new Type W5L VARIAC — the small, compact standard Type W5, 900 va unit, modified with windings of larger wire, with a 0 to 115-volt output range and a power rating of *1265 va!*

At very slight increase in price you get an increase of 365 va in capacity with the same exclusive advantages found in all VARIACS: Duratrak brush track construction — excellent regulation — perfectly smooth control — low losses — linear output voltage — moderate temperature rise — the most advanced mechanical design for long, efficient, trouble-free, low-maintenance life.

The physical size and all mounting dimensions of the new Type W5L are identical with those of Type W5.



type **W5L**
Variac:
$17.50
1265 va rating, 8.5 amps. rated, 11.0 amps. maximum

Essential Dimensions Type **W5L** *VARIAC*

	A	B	D	G	J	K	L	M	N	P	R	S	T	U	W	X
W5L	3 3/8	4 1/2	3 1/2	1/8	1 1/16	1 1/2	2 1/8	4	1/2	1/8	1/8	#31	1/8	1 1/8	10-32	1/4

Input Voltage	**115 volts, 60 cycles**	No. of Turns on Winding	235
Load Rating (va)	**1265**	D-C Resistance of Winding (Ω)	0.926
Output Voltage	0 to 115	Driving Torque (oz.-in.)	10-20
Rated Current (amp)	8.5	Replacement Brushes	VB-2 75¢
Maximum Current (amp)	11.0	Net Weight (lbs.)	6½
No-Load Loss at 60 c (w)	12	Code Word	COTUG
Dial Calibration	0-115*	**Price**	**$17.50**
Angle of Rotation (deg.)	325	Ball Bearing Surcharge (Add "BB" suffix to type number)	$7.00

*The 0-135 dial calibration on reverse is not used with the Type W5L

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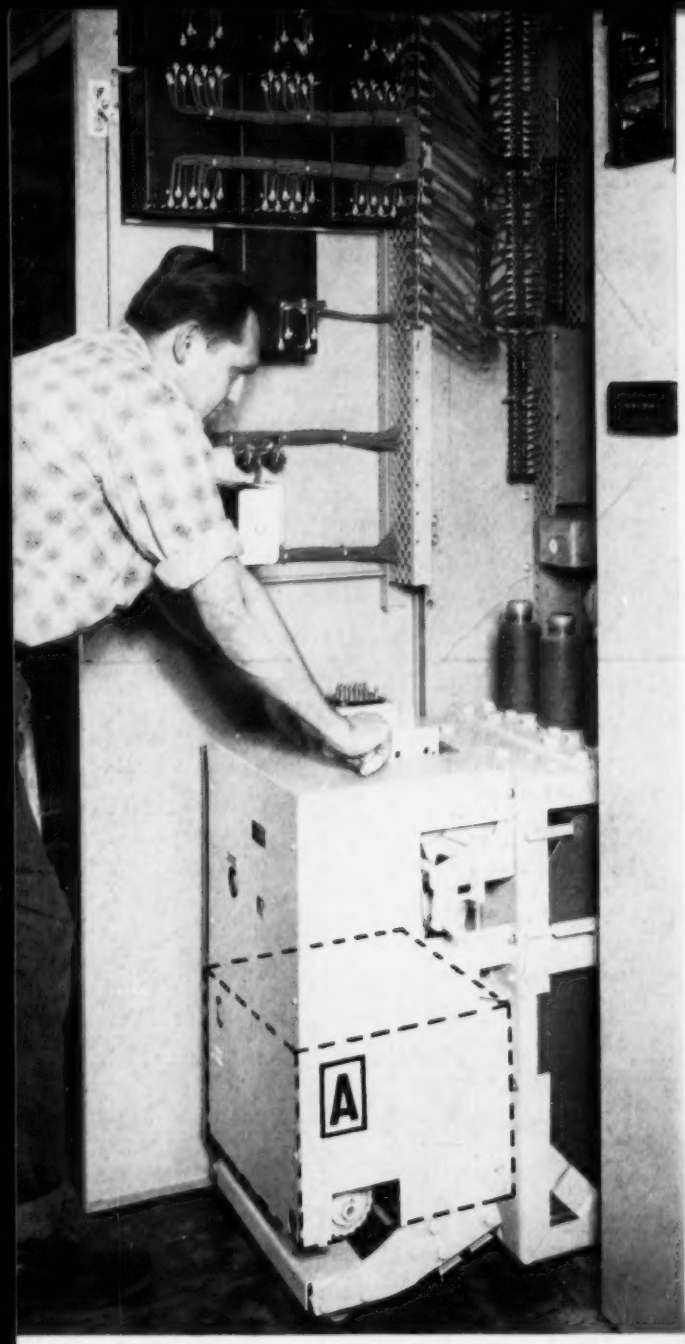


A 90% cut in control power for Metal-Clad Switchgear

A stored energy closing mechanism, latest of the engineering and design developments which make General Electric your most modern metal-clad switchgear buy, now offers you a 90% reduction in control power requirement. Magne-blast circuit breakers with interrupting ratings of 150 MVA or over are optionally available with this mechanism.

Here's what this feature can do for you:

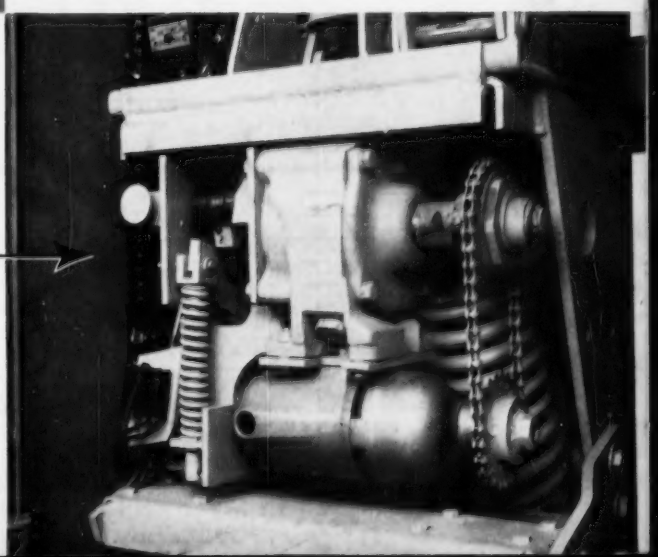
1. Eliminates requirement for 125 volt or 250 volt metal-clad operating battery.
2. Simplifies control power distribution system.
3. No high current voltage drop problems.
4. Permits simultaneous closing of any number of breakers without the high current problem.
5. Omission of AC closing rectifier eliminates associated maintenance and operating problems.
6. Built-in feature provides for safer, faster, manual emergency closing in event of loss of control power.

For additional information on this optional feature, write to Section 511-25, General Electric Company, Schenectady 5, New York.

Progress Is Our Most Important Product

GENERAL ELECTRIC

IN ADDITION to the optional stored energy closing mechanism, General Electric Metal-clad Switchgear and Magne-blast breakers offer all the PLUS values of solenoid-operated equipment, such as Self-X insulation, and easy maintenance.

A

ENERGY IS STORED in powerful springs. To close a breaker, it is necessary to energize only a low-energy release coil with the control switch and the springs do the rest. The springs are recharged by a fractional horsepower gear-motor in a few seconds.